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DEPARTMENT OF THE ARMY FIELD MANUAL

OPERATION OF THE AN/USD-1 SURVEILLANCE DRONE SYSTEM



HEADQUARTERS, DEPARTMENT OF THE ARMY
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HEADQUARTERS,
DEPARTMENT OF THE ARMY
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OPERATION OF THE AN/USD-1 SURVEILLANCE DRONE SYSTEM

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CHAPTER 1

INTRODUCTION

1. Purpose

This manual provides guidance for all units concerned with the organization, tactics, and techniques applicable to the training and employment of the drone section contained in aerial surveillance or target acquisition platoons within the division aviation battalion or the aviation company of the armored cavalry regiment. Guidance for tactical employment of the drone platoon in the field artillery target acquisition battalion is contained in FM 6-120 and FM 6-121. Technical description and procedures regarding drone flight preparation and operations contained herein are applicable to both type drone units.

2. Scope

a. The contents of this manual apply to the employment of the AN/USD-1 surveillance drone system.

b. The operations covered in this manual conform to tested and proven tactics and doctrine.

c. All aspects of drone operations conducted under tactical and administrative training situations are included.

d. Unless otherwise specified, the material presented herein is applicable without modification to both nuclear and nonnuclear warfare.

e. Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which changes are recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded direct to the Commandant, United States Army Aviation School, Fort Rucker, Ala.

f. For a list of references, see appendix I.

3. Mission

The mission of the drone section is to perform aerial photographic reconnaissance and surveillance and photographic target acquisition reconnaissance in conjunction with a mobile radar tracking unit. The drone section complements the aerial radar and aerial infrared sections of the aerial surveillance platoon and enhances the combat intelligence information collection effort of the division.

4. Assignment

The drone section is assigned to the aerial surveillance and target acquisition platoon of the general support company of the division's aviation battalion. It will be employed under the operational control of any unit or agency of the division for a specific mission, or it will be employed in general support of the division. It is also assigned to the drone platoon of the corps' field artillery target acquisition battalion and to the aerial surveillance platoon of the armored cavalry regiment's aviation company.

CHAPTER 2

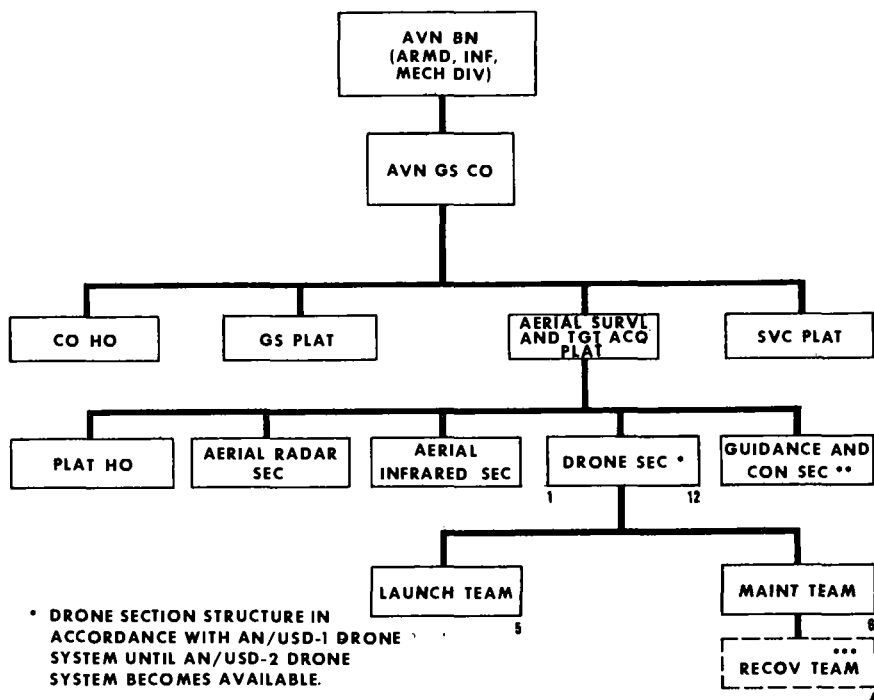
ORGANIZATION OF THE DRONE SECTION

5. Composition

The composition of the drone section within the typical aerial surveillance and target acquisition platoon is shown in figure 1.

a. Personnel.

1 Section commander	Lt	0590
1 Section chief	E7	105.70
1 Controller	E7	105.70
1 Launcher chief	E6	105.60
5 Control system mechanics	E5	209.20
4 Airframe and engine mechanics	E4	105.10



* DRONE SECTION STRUCTURE IN ACCORDANCE WITH AN/USD-1 DRONE SYSTEM UNTIL AN/USD-2 DRONE SYSTEM BECOMES AVAILABLE.

** GUIDANCE AND CONTROL SECTION WILL USE AN/MPO-29 TRACKING AND PLOTTING RADAR UNTIL AN/USD-2 DRONE SYSTEM BECOMES AVAILABLE.

*** RECOVERY TEAM FORMS AS REQUIRED FROM THE MAINTENANCE TEAM.

Figure 1. Typical drone section organization.

b. Section Equipment. The major components of the AN/USD-1B drone system are—

- 12 Drones, OA-2343/USD-1B.
- 12 Ejector sets, photoflash.
- 2 Telephone sets, TA-312/PT.
- 1 Radio set, AN/VRC-10 or 8.
- 1 Radio set, AN/VRC-18 or 16.
- 12 Transponder beacons, AN/DPN-62.
- 12 Cameras, KA-20A or KA-39A.
- 3 Launchers, ZL-3.
- 3 Hydraulic starter carts, MX-2772/USD-1.
- 2 Ground control stations (1 station mounted in 1/4-ton trailer).
- 4 Drone transporters, 2 1/2-ton, LWB.
- 2 Cargo trucks, 2 1/2-ton.
- 1 Electronic maintenance van, 2 1/2-ton.
- 2 Trucks, 1/4-ton.
- 1 Launch area trailer, 1 1/2-ton.
- 1 Trailer with PU-290/MR power unit, 1 1/2-ton.
- 1 Fuel supply trailer, 1/4-ton.
- 3 Cargo trailers, 1 1/2-ton.
- 1 Steel frame maintenance tent with miscellaneous support equipment and assorted spare parts.

6. General Duties of Personnel

a. Section Commander. The drone section commander—

- (1) Exercises command of the section, and directs and supervises drone operations and organizational maintenance on assigned equipment.
- (2) Makes recommendations to the platoon commander or to other supported commanders on the employment, capabilities, and limitations of the section.
- (3) Keeps the platoon commander informed of the operational status of the section.
- (4) Is responsible for coordination of flight plans with the Flight Coordination Center when detached from the Aerial Surveillance Platoon.
- (5) Insures expeditious delivery of exposed films to the photographic laboratory.

b. Section Chief. The drone section chief—

- (1) Assists the section commander and supervises the employment, maintenance, and administration of the drone section.
- (2) Supervises the launching and recovery of drones and the final prelaunch checkout of drones and sensors.
- (3) Coordinates with the team chief of the tracking and

plotting team to insure that the radar is physically located to insure maximum effectiveness in tracking the surveillance drone.

- (4) Performs route and area reconnaissance, and supervises security measures.
- (5) Supervises preparation of launching sites.

c. *Controller.* The controller—

- (1) Coordinates with the section commander and platoon headquarters for mission assignments.
- (2) Assembles and puts into operation the ground control station.
- (3) Preplots the mission on the radar plotting board from the launch area to the target and back to the recovery area. Makes notations of the flight altitudes and other information at certain checkpoints along the flight route.
- (4) Controls the drone by operating the ground control box during in-sight flying and radar tracked flights.

d. *Launcher Chief.* The drone section launcher chief—

- (1) Supervises crew members in the preparation of the drone.
- (2) Is responsible for the launching and recovery of drones, and the final prelaunch checkouts of drones and sensors.
- (3) Is responsible for assembly and disassembly of the drone aircraft.
- (4) Is responsible for preparing, relocating, and disassembling the launching sites.
- (5) Keeps the drone section chief informed on the status of the drone aircraft and launch equipment.
- (6) Determines whether or not the drone operating conditions are satisfactory for launching.

e. *Control System Mechanics.* The control system mechanics—

- (1) Repair and maintain drone control systems.
- (2) Perform organizational maintenance on allied radio and test equipment.
- (3) Maintain storage batteries, servos, and gyros.
- (4) Perform installation of the control system in the drone in preparation for launching.
- (5) Assist in checkout, launching, and recovery of drone.
- (6) Assist in diagnosis of complex malfunctions.
- (7) Prepare and maintain required maintenance forms and records.
- (8) Perform organizational maintenance and install sensor equipment.

f. *Airframe and Engine Mechanics.* The airframe and engine mechanics—

- (1) Maintain drone aircraft by performing periodic inspections, diagnosing operational defects, repairing damage, and adjusting and replacing parts and assemblies.
- (2) Maintain engines, start engines, and regulate fuel mixture for optimum engine performance.
- (3) Fold, pack, install, and retrieve drone parachutes.
- (4) Assist in launching and recovery procedures.
- (5) Prepare and maintain required maintenance forms and records.

7. Capabilities and Limitations

a. Capabilities. At full strength this section has the following capabilities:

- (1) Provides the armored, infantry, and mechanized division and the armored cavalry regiment with the capability to conduct unmanned day and night photographic target acquisition, surveillance, and reconnaissance.
- (2) Performs missions when and where the employment of manned aircraft is not feasible or desirable, and when manned aircraft are not available (e.g., when weather is poor, where radiation is great, or where hostile air defense capabilities are great).
- (3) Performs photographic aerial surveillance and reconnaissance without the necessity of improved takeoff and landing areas.
- (4) Capable of launching a drone within 20 minutes from time of arrival in the launch area.
- (5) Provides greater security for the division by timely and accurate information of the enemy and terrain.

b. Limitations.

- (1) The drone has an endurance of 30 minutes, giving it an approximate operational radius of 65 kilometers.
- (2) Satisfactory vertical photographs can only be taken at altitudes of 400 feet and above.
- (3) Meteorological conditions place the following limitations on drone operations:
 - (a) A minimum ceiling of 700 feet and visibility of one mile is the optimal condition for launching. However, for emergency missions, the radar can lock-on the transponder beacon when the drone is on the launcher and launch under zero-zero conditions.
 - (b) To obtain suitable photographs, the vertical visibility must be clear up to the altitude of the desired photorun.
 - (c) To employ the AN/MPQ-29 tracking radar, the drone must maintain clearance from high moisture content

clouds or radar contact will be lost. (For further details, see par. 26b(3) and TM 1-300.)

- (d) Drone launching and flight is critical when wind velocities are in excess of 25 knots or the gust spread exceeds 15 knots.
- (4) The number of drone flights per day (24 hours continuous operation) will normally vary from four to six depending on the training status of the unit and the maintenance time required per drone.
- (5) Approximately 50 minutes is required to process a mission request from time of launch to delivery of a wet negative to a photo interpreter, providing a photo processing unit is immediately available at the recovery site.
- (6) The drone is vulnerable to most types of air defense fire.
- (7) The drone guidance and tracking systems are not secure against electronic countermeasures (ECM).

8. Planning and Coordination

The G2 normally exercises general staff supervision over the aerial surveillance collection activities of the division. Mission requests are processed to G2 air group of the tactical air support element in the force tactical operations center. If the requests are within the capabilities of aviation means organic or attached to the force and aircraft are available to perform the mission within the time desired, the requests are passed to the chief of the Army aviation element in the force tactical operations center (TOC) for implementation.

a. Planning. Mission planning should use the maximum reconnaissance capabilities of the drone section and follow an established SOP for operation of the drone section. For further details on mission planning, see chapter 8.

b. Coordination. The success of a mission is dependent upon the extent and thoroughness of planning and coordination between the supported and supporting commanders.

CHAPTER 3

EQUIPMENT AND FACILITIES

Section I. AN/USD-1 DRONE SYSTEM

9. General Description

The AN/USD-1 surveillance drone system in a tactical unit consists of radio-controlled drone aircraft (fig. 2), ground support system, and trained personnel necessary to operate and maintain the drone and its related equipment.

10. AN/USD-1 Surveillance Drone

The drone is an unmanned aircraft which is remotely controlled by radio from a ground control station. The drone is designed for zero-length launching using two rocket motors. Propulsion is by a 4-cylinder, horizontally opposed, 2-cycle, air-cooled engine (fig. 3). The drone electrical system is powered by a 28-volt nickel cadmium battery. Flight control and automatic stabilization of the drone are provided by a proportional flight control system.

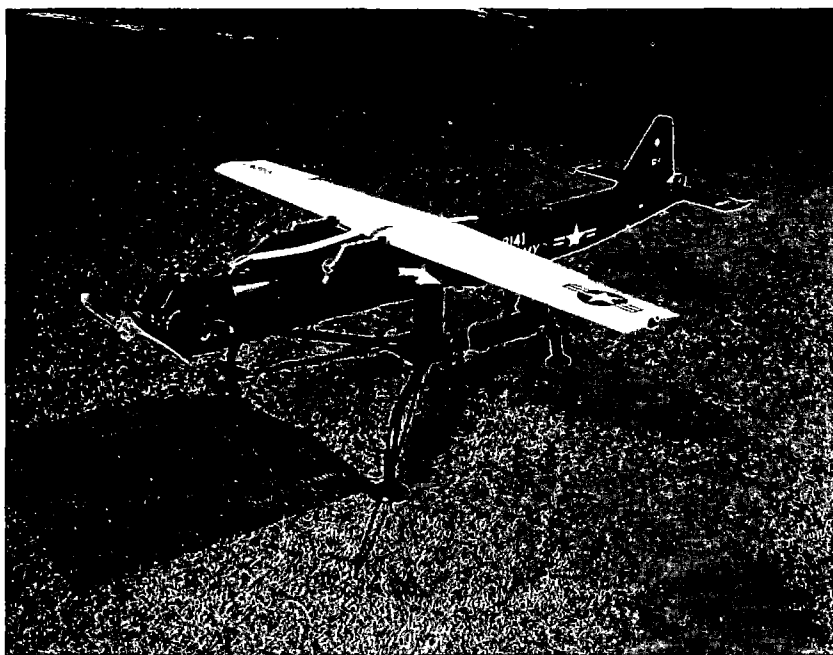


Figure 2. AN/USD-1 surveillance drone mounted on launcher.

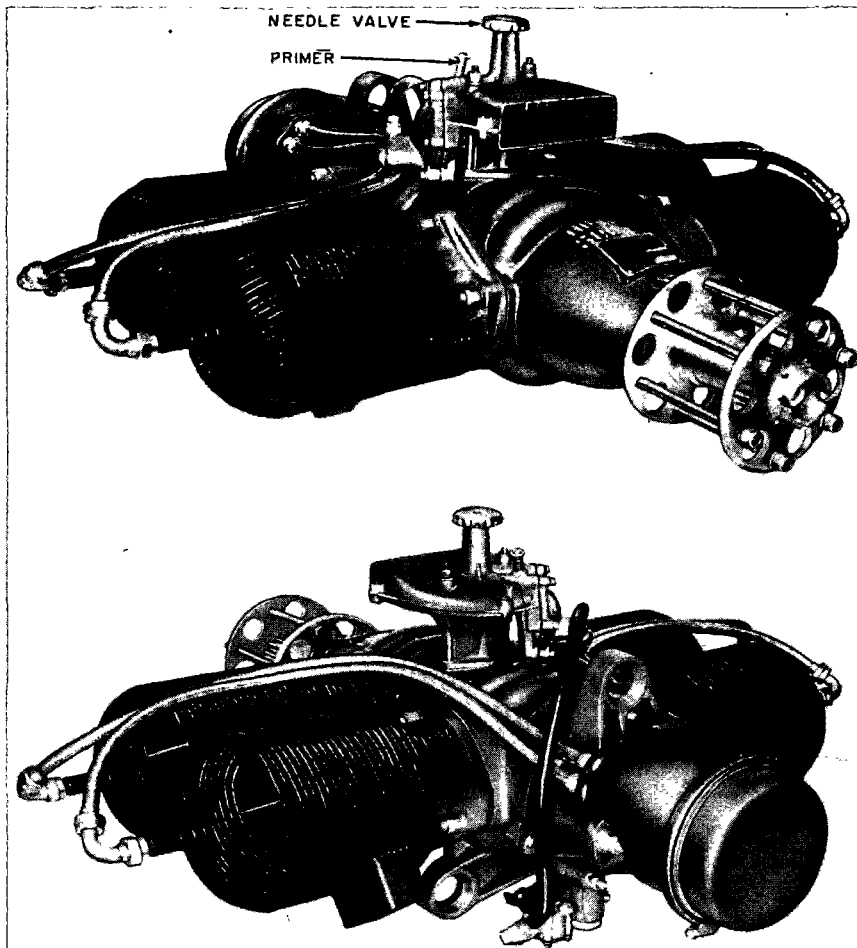


Figure 3. Drone engine.

Signals to operate the control, recovery, and sensory systems are supplied by a frequency modulated transmitter in the ground control station. The primary components (fig. 4) are described below. (See TM 55-1550-200-12 for more detailed description.)

a. Primary Components.

- (1) *Proportional flight control system.* The flight control system consists of two elements, the ground control station (par. 12c) and the remote airborne flight control system ((a) through (e) below).
- (a) The receiver (fig. 5) detects the frequency modulated radio frequency (RF) carrier and converts the resultant audio output into properly polarized voltages

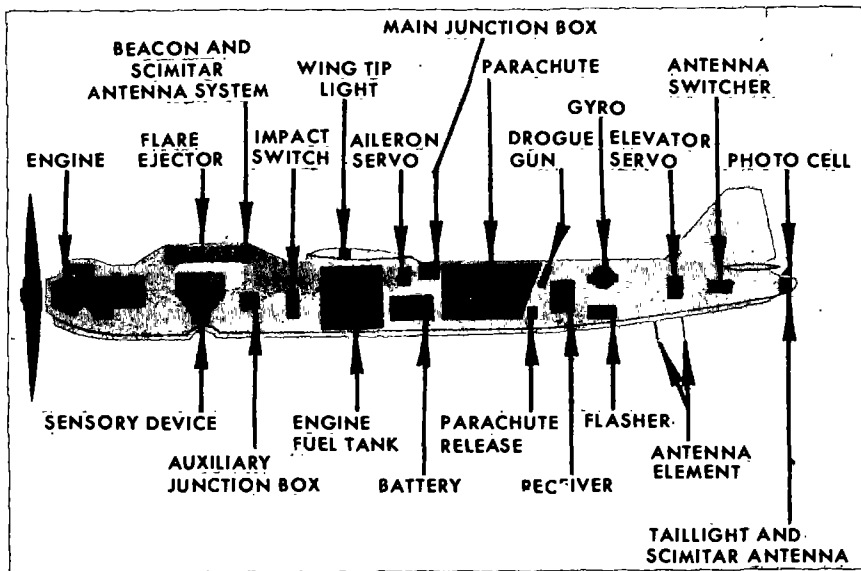


Figure 4. Drone components.

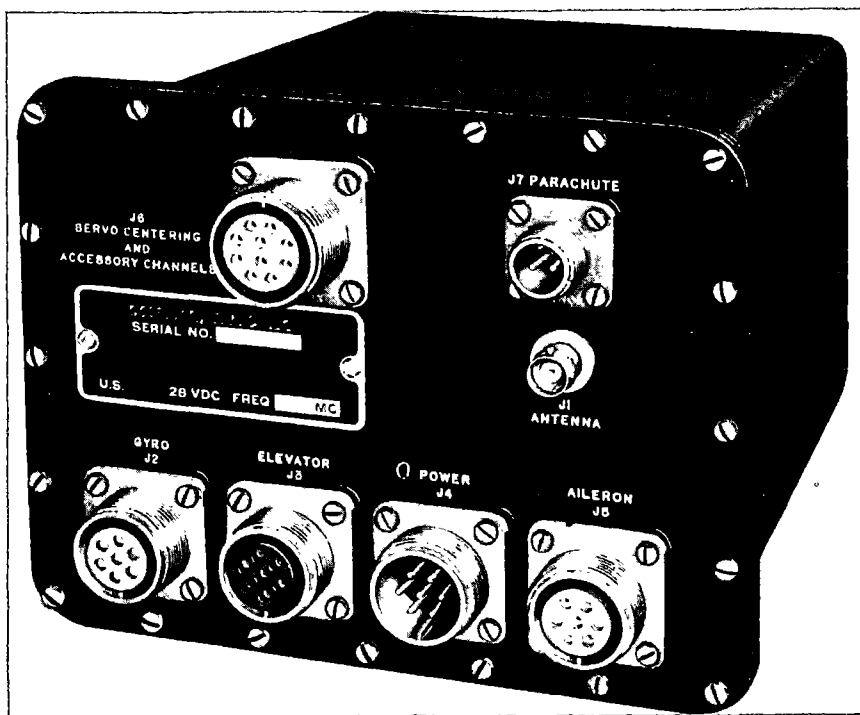


Figure 5. Receiver.

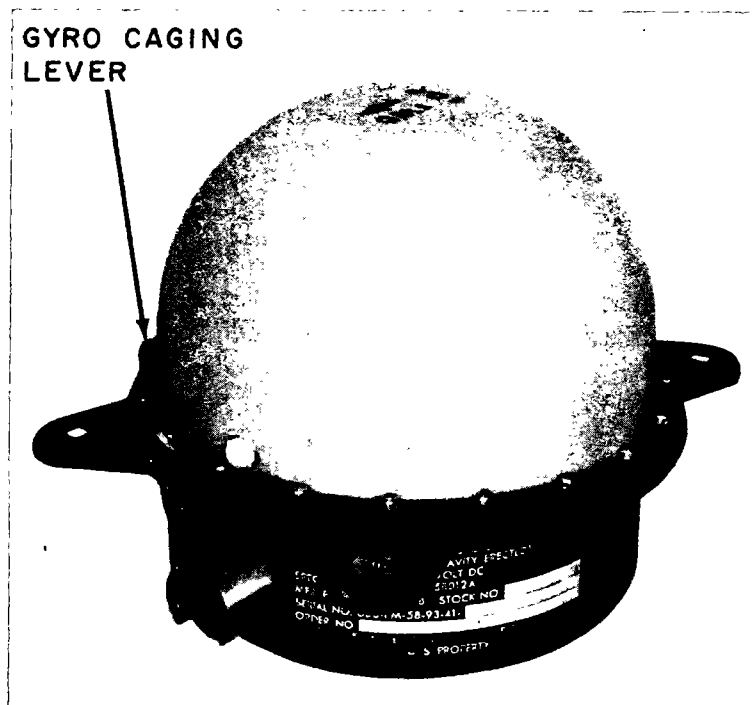


Figure 6. Gyro.

which operate relays in the receiver. These relays function through the main junction box and interconnecting cables to complete the circuit to an applicable component within the flight control system, or to the camera, night lights, or parachute release mechanism. Receiver components are contained within a waterproof metal housing which is attached to shock mounts in the midsection of the drone fuselage. The receiver operates in the range of 406 to 420 megacycles (mc) and is capable of simultaneous reception of six channels of frequency modulated (FM) control commands.

- (b) The gyro (fig. 6) senses departure of the drone from a given flight attitude. Stabilization voltages are produced by the gyro when this occurs. These voltages are applied through the amplifier portion of the receiver to the servos as necessary. The servos move their related control surfaces in the appropriate direction through mechanical coupling. The stabilization voltages are of appropriate amplitude and polarity to return the drone to the original flight attitude. They

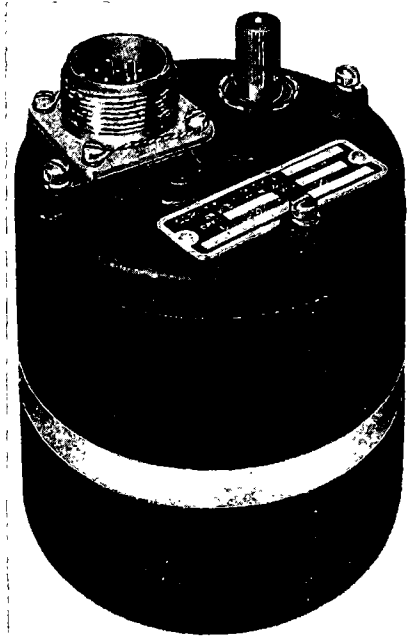


Figure 7. Servo.

have essentially the same stabilization effect on the amplifier portion of the receiver as do the command RF signal pulses. The gyro has a caging lever which, when pushed as far as possible to the right, holds the gyro erect until the motor reaches the proper speed.

- (c) The aileron (roll) and elevator (pitch) servos (fig. 7) mechanically position their related flight control surfaces. They perform the desired flight attitude changes in response to receiver signals.
- (d) The antenna element and switcher provide a system for continuous signal reception. Two antennas, one mounted on the midsection and one on the aft section of the fuselage, receive command signals from the ground control station. The use of dual antennas with an antenna switcher (fig. 8) reduces signal loss due to shielding of the antenna by the drone fuselage. The antenna switcher changes the signal received from one antenna to the other at a rate of 600 cycles per second (cps).
- (e) Associated interconnecting cables connect from the electrical system to components of the remote flight control system and between its components.

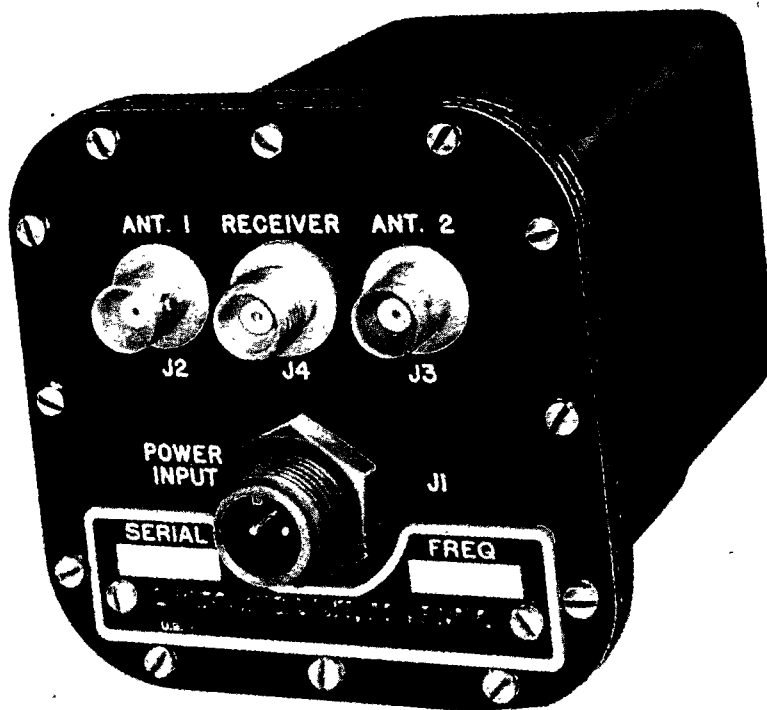


Figure 8. Antenna switcher.

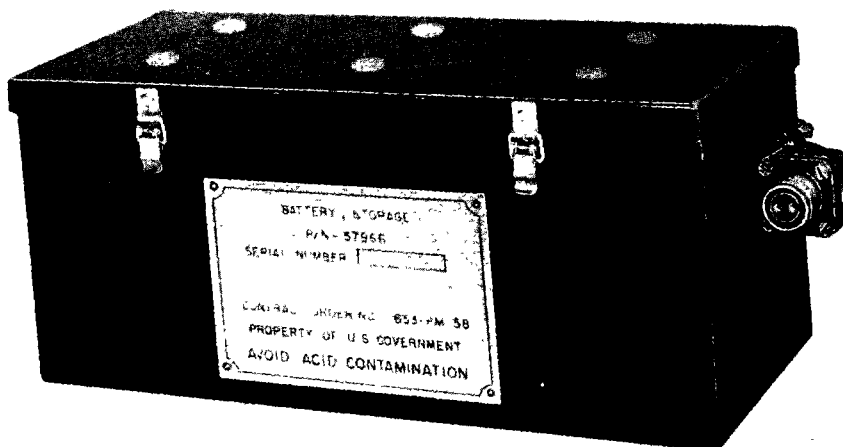


Figure 9. Battery.

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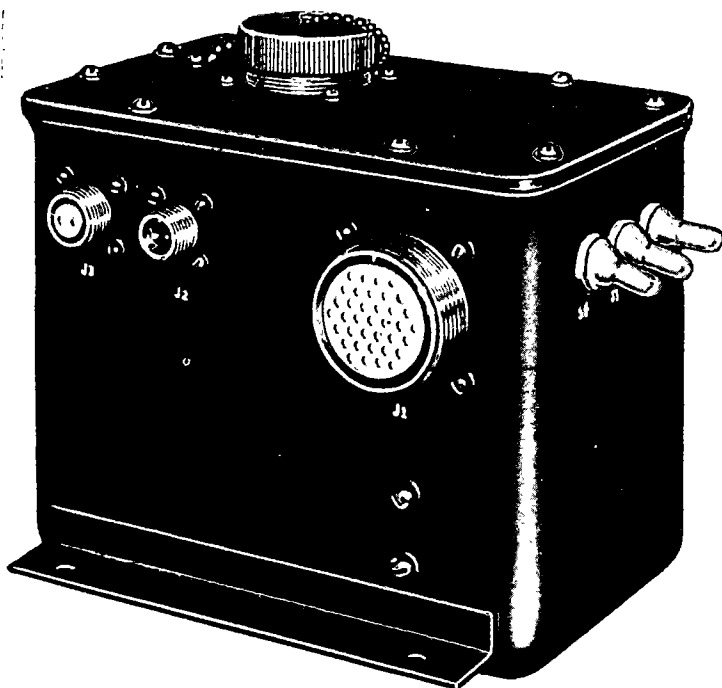


Figure 10. Main junction box.

- (2) *Electrical system.* The electrical system consists of the following primary components:
 - (a) The BB-421/USD-1 battery (fig. 9) is contained in a metal case made up of twenty-two $1\frac{1}{2}$ -volt nickel-cadmium cells. It has a 28-volt, 6 ampere (amp) hour capacity at full charge. The battery can be fully discharged and recharged any number of times. For information on battery charger, see paragraph 11d (3).
 - (b) The main junction box (fig. 10) completes the circuitry between the drone components for power and receiver commands. It also provides a means of connecting the test console and external power to the drone for test purposes.
 - (c) The auxiliary junction box (fig. 11) contains one relay, used for the spare channel circuit, to provide power for the AN/DPN-62V transponder beacon.
 - (d) Other components of the electrical system are the aileron and elevator limit switches and night lights.
- (3) *Recovery system.* The recovery system consists of the following components mounted on or within the fuselage:

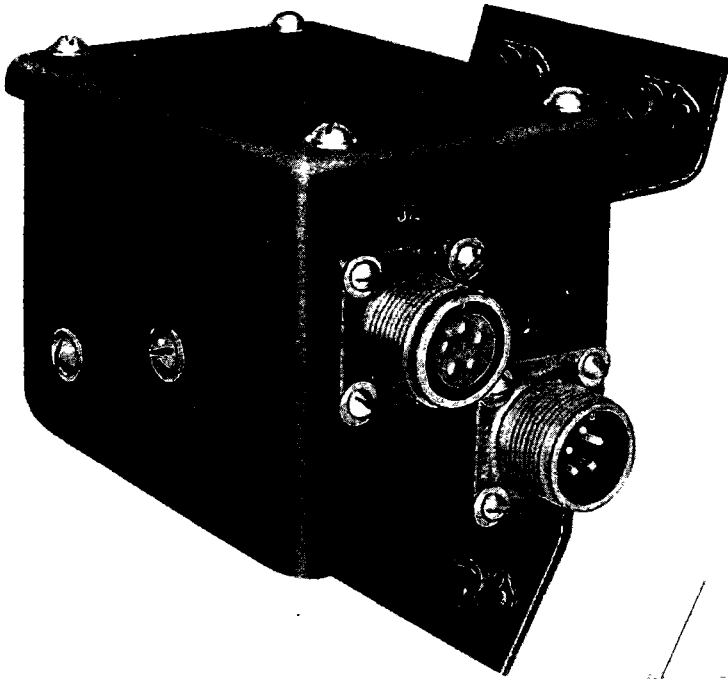


Figure 11. Auxiliary junction box.

the parachute door release mechanism, the drogue gun, the pilot parachute, the main parachute, and the impact switch. The parachute has a pilot chute which is extracted from the drone by the firing of a drogue gun after the parachute door opens 50°. The parachute is connected to the drone by a riser harness and a release assembly. The impact switch (fig. 12) is actuated by the impact of the drone with the ground. When the switch closes, an explosive squib located within the release assembly fires and separates the parachute from the drone.

b. Accessory Components.

(1) Sensory devices.

- (a) The KA-20A camera (fig. 13) is a compact, electrical and vacuum operated, aerial reconnaissance camera. It takes a continuous series of wide field photographs during daytime only. Mounting is in the forward section of the drone just aft of the engine. The camera is actuated by command control from the ground control station. It produces a 9 by 9 inch format giving 95 exposures per roll. Pictures can be taken from alti-

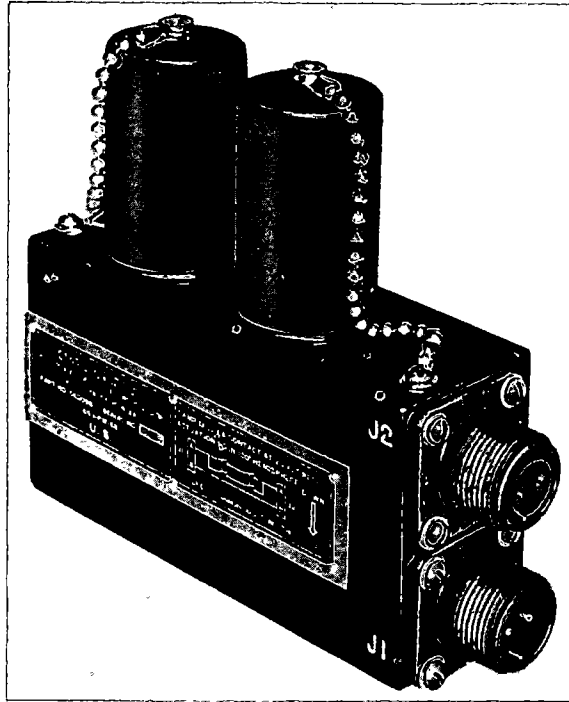


Figure 12. Impact switch.

tudes of 400 to 4,000 feet. For more details, see paragraph 49b and TM 11-6720-203-10.

(b) The KS-20A camera system is employed in the drone and consists of the following:

1. The KA-39A camera (fig. 14) is a self-contained, compact, electrically operated aerial reconnaissance camera. It takes a continuous series of wide field photographs during day or night aerial reconnaissance. Mounting is in the forward section of the drone just aft of the engine. The camera produces a 9 by 9 inch format giving 95 exposures during day operation. A limit of 10 exposures per flight is available for night operations since the system can only accommodate 10 photoflash cartridges. Pictures can be taken from altitudes of 1,000 to 5,000 feet during daytime and 1,000 to 2,000 feet at night. For more details, see paragraph 49 and TM 11-6720-207-10.
2. The control box (fig. 15) is used to control the operation of the camera (fig. 14) and the photoflash cartridge ejectors (fig. 16). The control box is

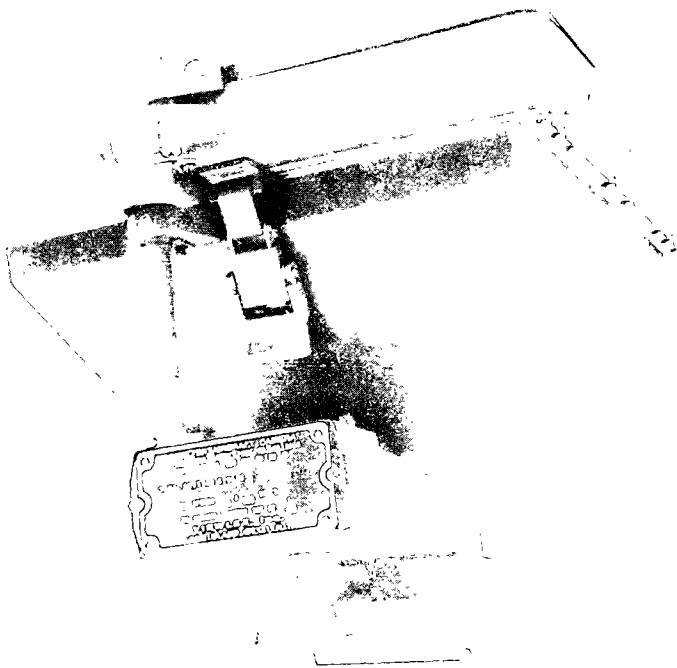


Figure 13. KA-20A camera.

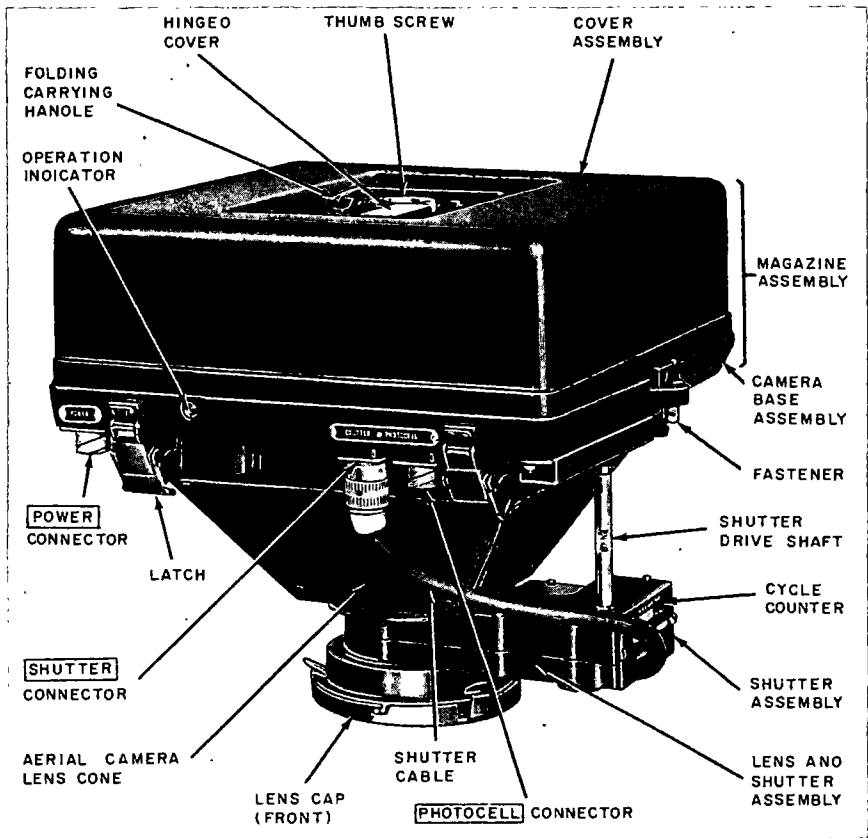


Figure 14. KA-39A camera.

mounted behind the camera in the forward fuselage section.

3. The photoflash cartridge ejector (fig. 16) consists of two photoflash cartridge ejector pods mounted on the left and right side of the forward fuselage section. Each pod is capable of holding and ejecting five M-112 photoflash cartridges. For more details on M-112 photoflash cartridges, see TM 9-1370-200. Details of operation and use of the KS-53A camera system will be found in paragraphs 18 *a-e* and 49.
4. The photoflash detector consists of a photoelectric cell mounted on the rear of the aft fuselage section (fig. 17). The detector triggers the camera control when the proper candlepower of light is reached.

- (2) *AN/DPN-62V transponder beacon.* The AN/DPN-62V transponder set (fig. 18) is a miniature transponder

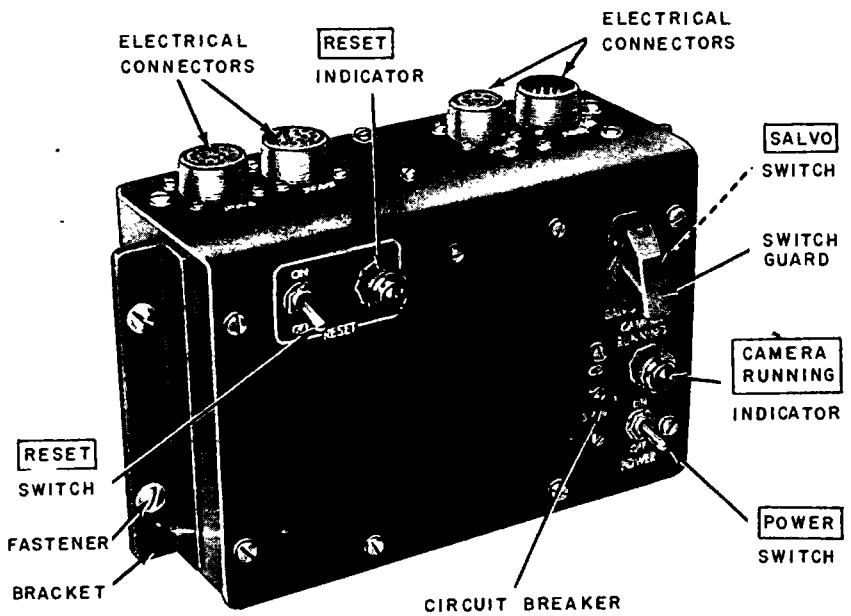


Figure 15. Control box assembly for KA-39A Camera.

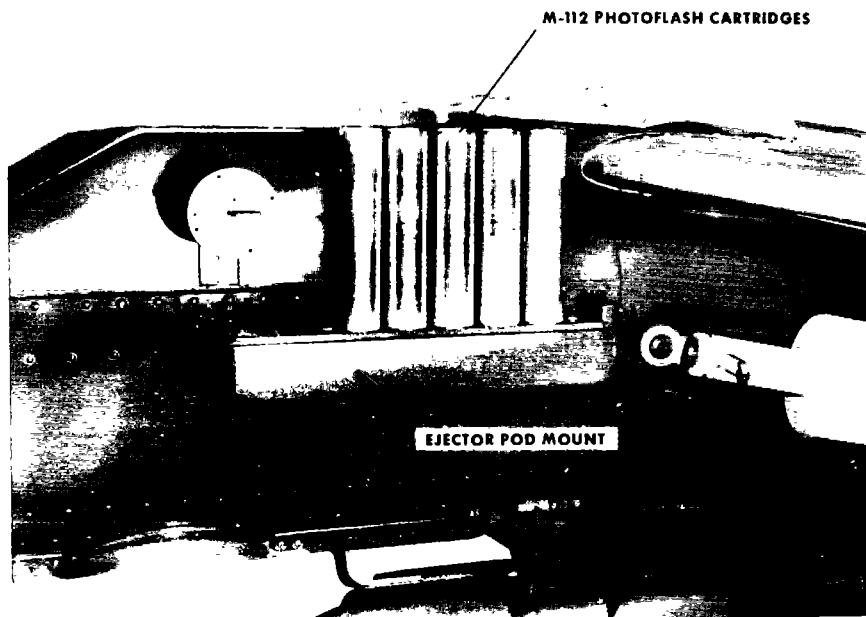


Figure 16. Photoflash cartridge ejector pod, left side.

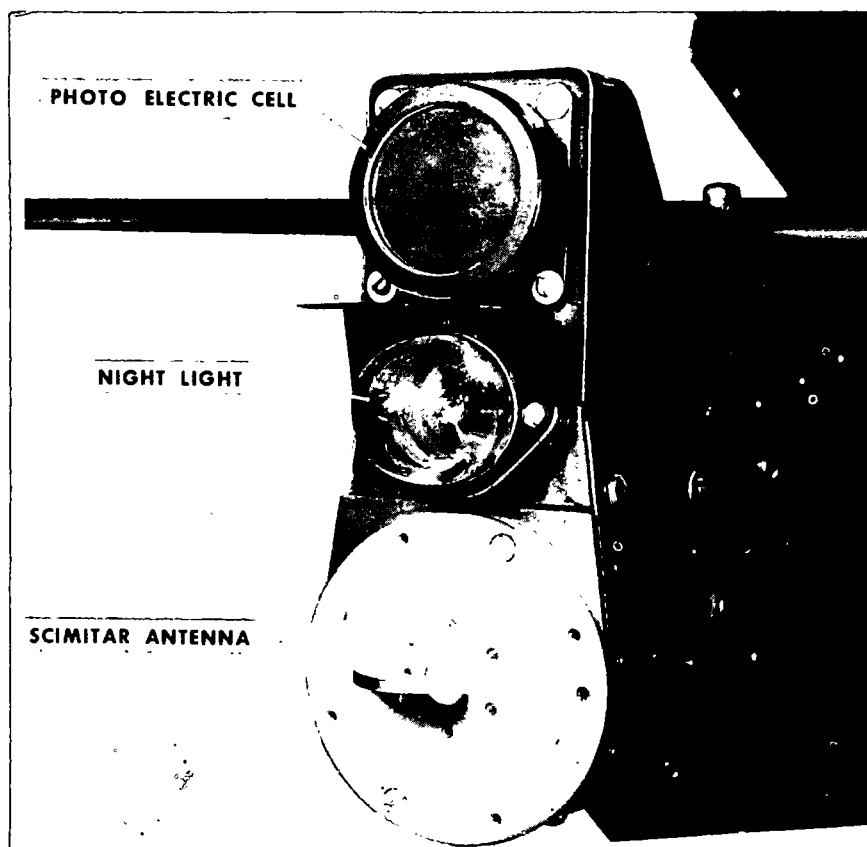


Figure 17. Equipment mounted on rear of aft fuselage section.

beacon for general use as a tracking aid in drone and manned aircraft. The beacon operates at X-band frequencies from 8,500 to 9,600 megacycles (mc), and responds to either single- or double-pulse interrogation from an associated ground-based, X-band tracking radar (e.g., radar set AN/MPQ-29). The transponder beacon receives and transmits its signals through three scimitar antennas located one each on the left and right side of the forward fuselage section in front of the photoflash cartridge ejector pods and one on the rear of the aft fuselage section (fig. 17). The transponder beacon is capable of being tracked to the maximum range of the radar (92 kilometers) providing radar line-of-sight is maintained (e.g., at an altitude of 400 feet, which is the minimum altitude for operation of the cameras, the maximum

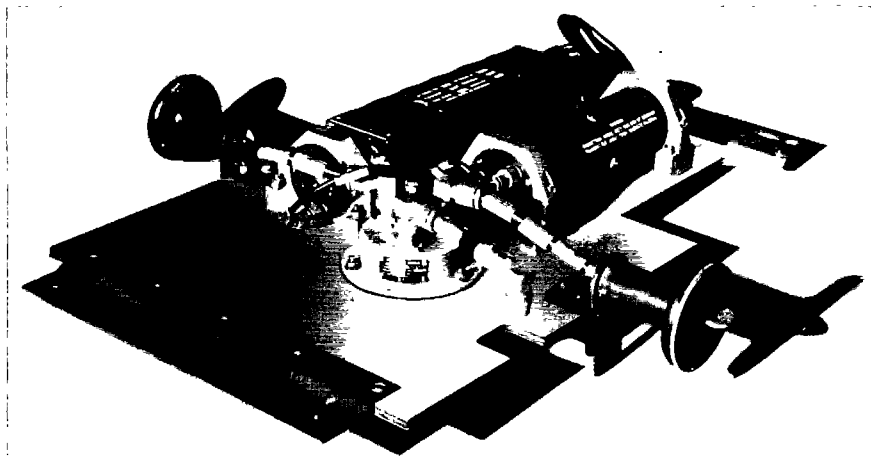


Figure 18. AN/DPN-62V transponder beacon.

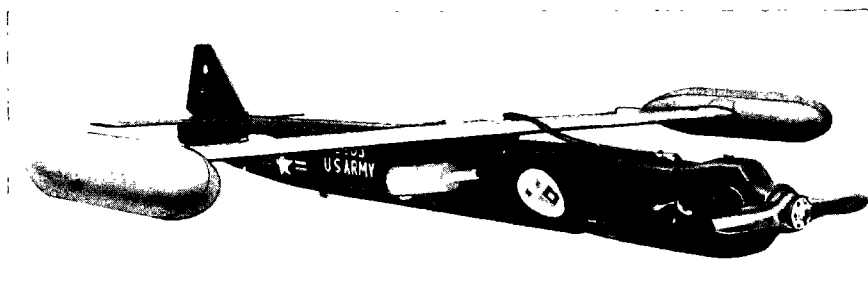


Figure 19. AN/USD-1 drone with radar reflector pods.

radar line-of-sight range is approximately 45 kilometers). However, in field tests only a consistent maximum range of 18 kilometers has been obtained.

- (3) *Radar reflector pods.* Radar reflector pods (fig. 19) are fiberglass pods which contain aluminum cross sections. They are used to increase the radar sensitivity of the drone during the skin tracking mode of radar operation (par. 26b). The radar reflector pods are attached to the wings by use of attaching ribs installed on the wingtips.

11. Maintenance Area Equipment

a. *Truck-Mounted Electronic Maintenance Shop.* The electronic maintenance van (fig. 20) consists of an M109 or M220 shop van,

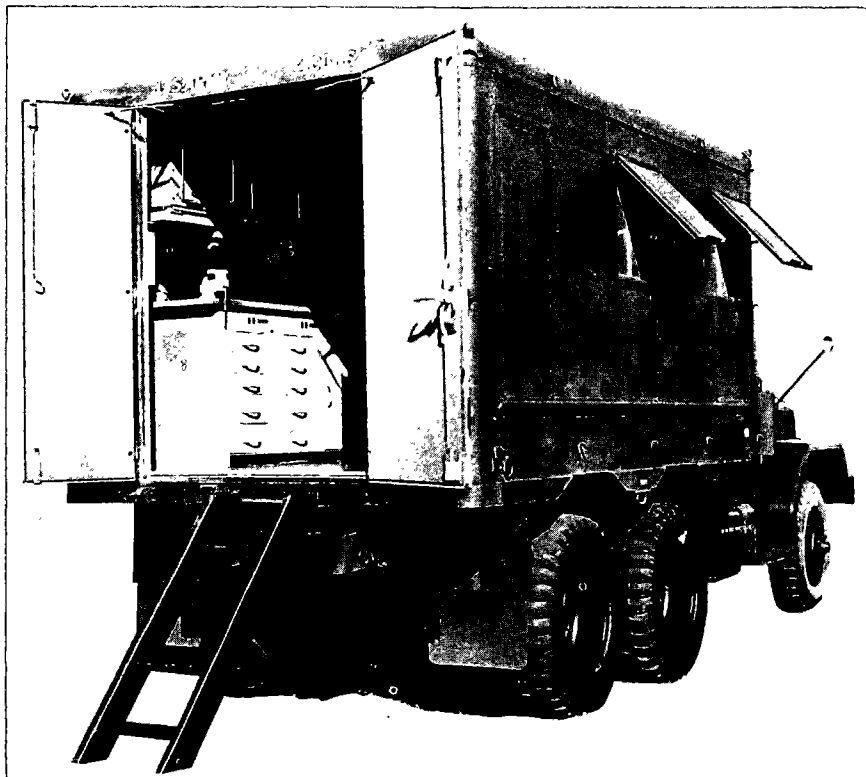


Figure 20. Truck-mounted electronic maintenance shop.

modified to incorporate work benches, cabinets, instrument racks, tools, tool storage drawers, overhead lights, bench lights, and test equipment. The van is used with an associated power supply unit to perform electronic tests and maintenance.

b. Power Supply Unit. The generator trailer assembly consists of the PU-290/MR power unit mounted on a 1½-ton M104 trailer (fig. 21). The power unit is a gasoline engine-driven ac generator with an output of 10 kilowatts at 120/240 volts ac and is described in detail in TM 5-6115-232-10.

c. Spare Parts Vehicle. Two 1½-ton, M104 cargo trailers are used for storage and transport of repair parts and miscellaneous equipment.

d. Miscellaneous Tools and Equipment.

- (1) The maintenance tent (fig. 22) provides a sheltered maintenance area with enough tools and equipment to perform required maintenance and repair through 4th echelon.

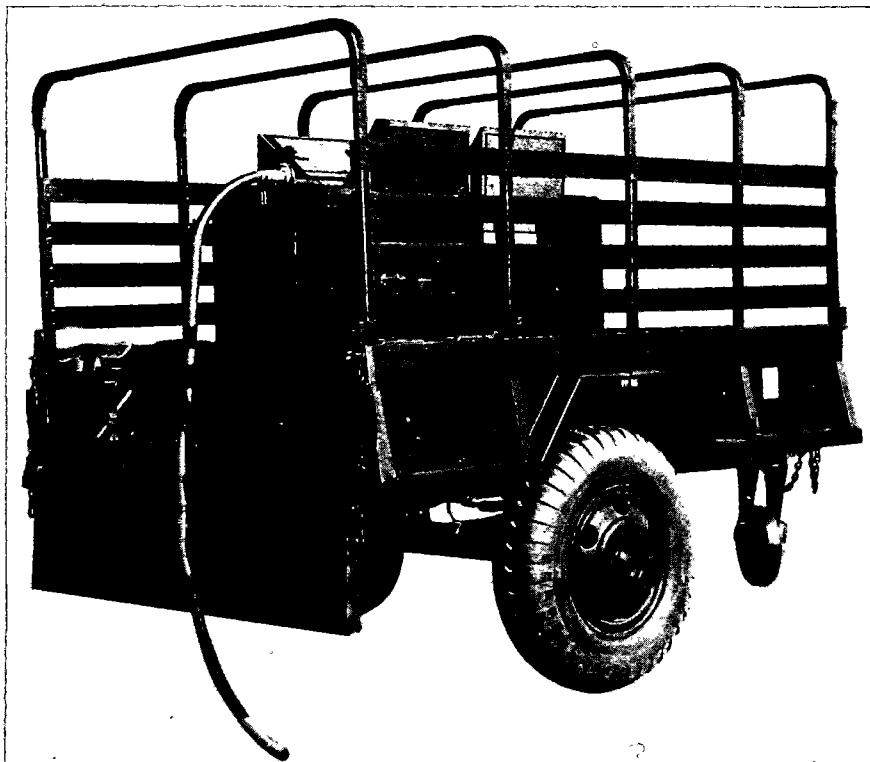


Figure 21. Power supply unit.

- (a) *Portable work benches.* Six work benches are electrically interconnected by a cable and connector system. Each has two lamps and three external power outlets.
 - (b) *Tool kit.* The tool kit contains all of the necessary handtools and special tools required to perform maintenance and repair on the drone and its related equipment.
 - (c) *Maintenance area electrical cable set.* This set contains cable assemblies, trouble lights, electrical extension cords, switchbox and overhead light kit, and the main power distribution box. The function of the main power distribution box is to distribute power from the ac generator to the maintenance tent and the electronic maintenance van.
 - (d) *Storage cases.* Three aluminum storage cases are provided to store small items of maintenance area components.
- (2) The drone handling equipment used in the maintenance area includes—

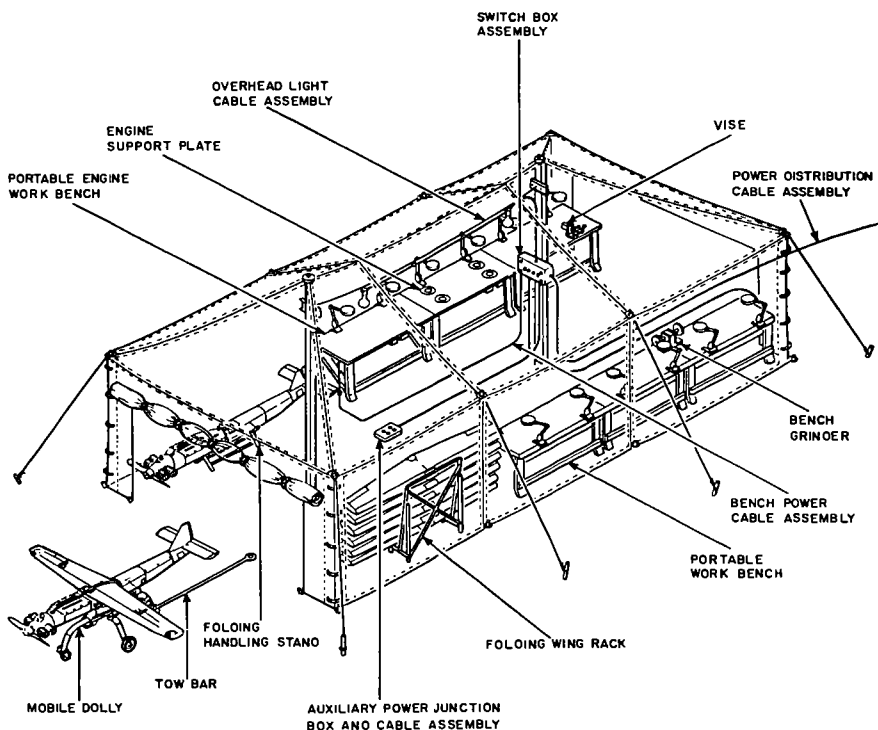
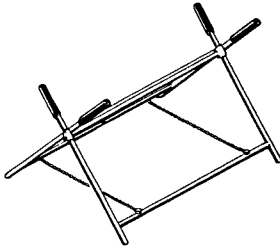
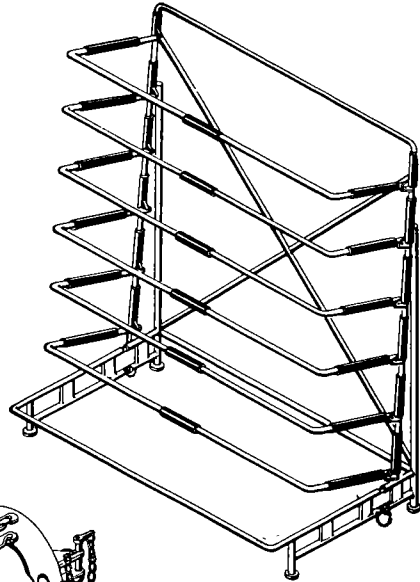


Figure 22. Maintenance tent.

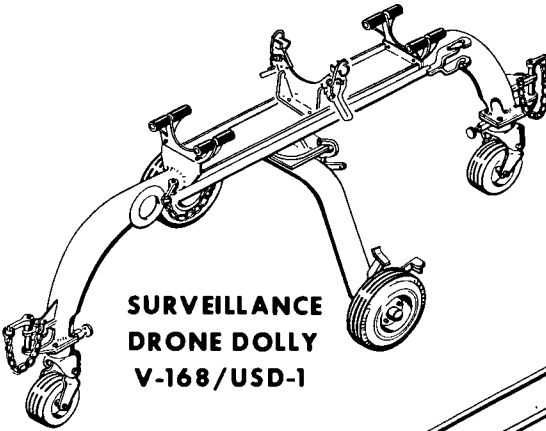
- (a) *Drone stand.* The handling stand (fig. 23) supports the drone during maintenance. It consists of two welded tubular steel frames which are bolted together to form an X-type support. The drone section has eight stands which are easily folded for shipping and storage.
- (b) *Wing rack.* The wing rack (fig. 23) consists of a tubular steel frame with provisions for temporary storage of six drone wings. The base of the rack is removable and each wing rack can be folded against the frame or removed completely when the rack is transported or stored. The drone section has one rack.
- (c) *Drone dolly.* The dolly (fig. 23) is used to move the drone about the maintenance and launch areas. The dolly is tubular steel and is supported on each by a spring-mounted caster assembly. Balance of the dolly is maintained by an outrigger wheel assembly mounted on rubber-tired wheels. The wheels are provided with brakes actuated and released by separate foot pedals on each wheel. Two steel pins (one located



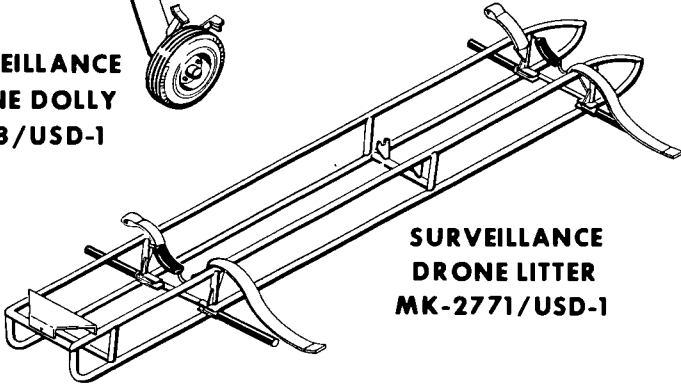
**SURVEILLANCE
DRONE STAND
MT-2197/USD-1**



**SURVEILLANCE
DRONE WING RACK
MT-2196/USD-1**



**SURVEILLANCE
DRONE DOLLY
V-168/USD-1**



**SURVEILLANCE
DRONE LITTER
MK-2771/USD-1**

Figure 23. Drone handling equipment.

above each caster) are provided for attaching a tow bar. A heavy-duty, rubber-cushioned locking cradle and brackets secure the drone to the dolly. The drone section has three dollies.

- (d) *Drone litter.* The litter (fig. 23) consists of a welded tubular steel frame and cradle. A rubber-cushioned cradle on each end of the litter protects the drone dur-

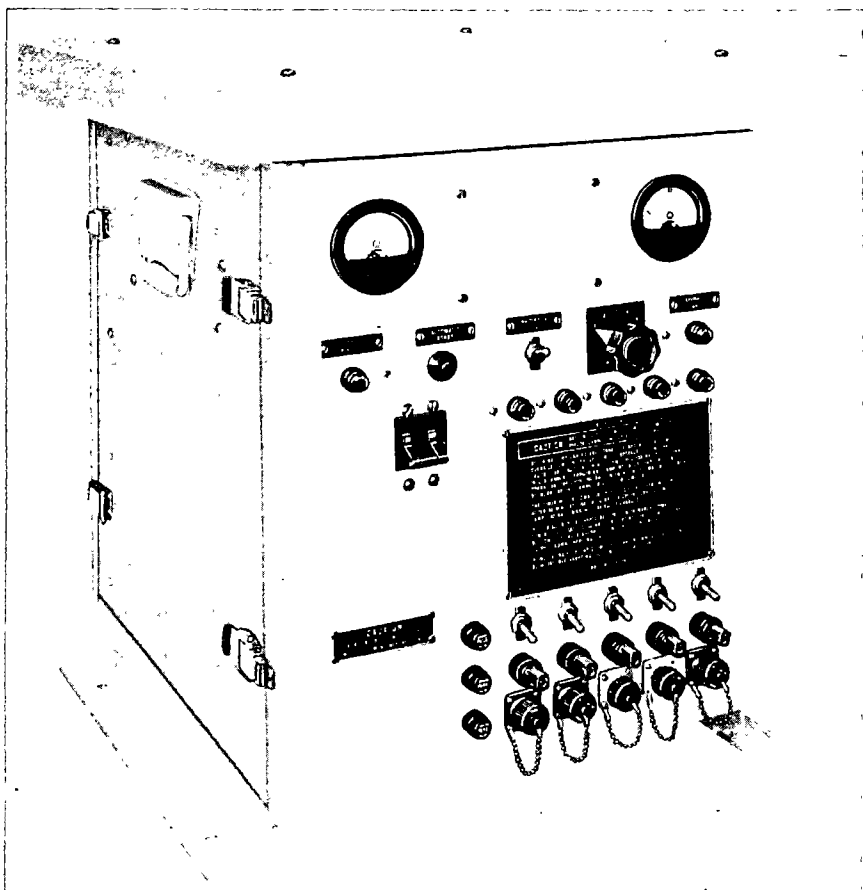


Figure 24. Battery charger.

ing handling. Webbing belts secure the drone to the litter. Tension is adjusted on the belts by safety buckles. Skids on the bottom of the litter permit personnel to drag the litter, if necessary. The litter has four folding handles which are used when carrying a drone. There are three litters within the section.

- (3) The battery charger (fig. 24) consists of a constant-potential charger housed within a metal case. It can charge one to five batteries at a time. Charging can be accomplished automatically for a specific period of time or can be regulated manually.
- (4) The parts washer (fig. 25) is used in washing drone engine parts. It consists of a 3-gallon capacity welded steel tank and an electric pump fitted with a fountain

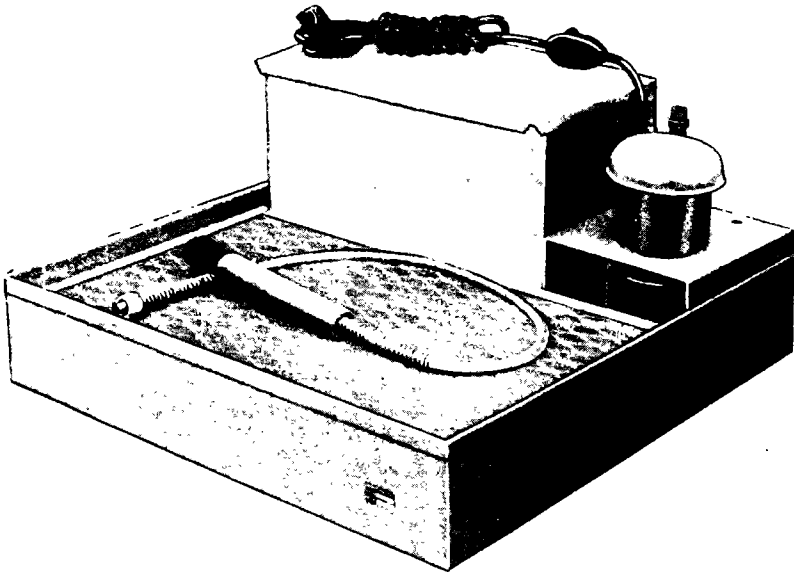


Figure 25. Parts washer.

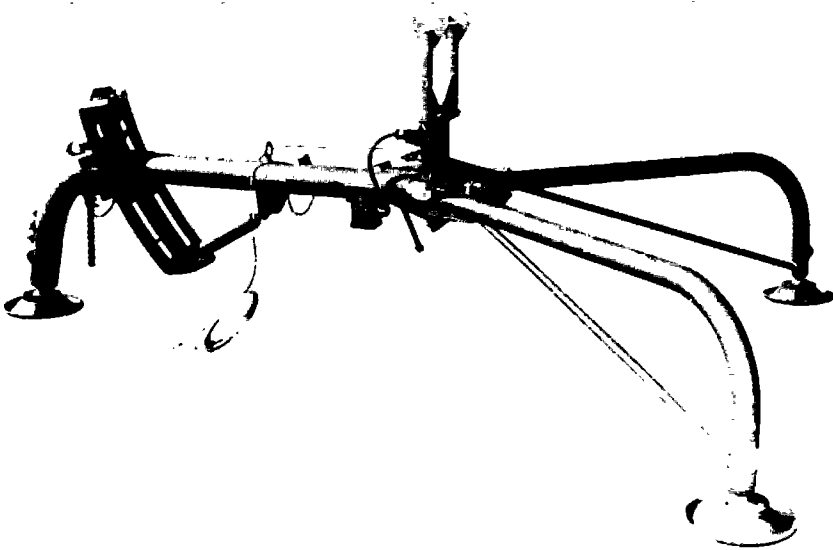


Figure 26. Zero length launcher.

brush. The solvent is recirculated through the fountain brush at a rate of 15 gallons per hour. (See TM 11-5895-246-12 for operation.)

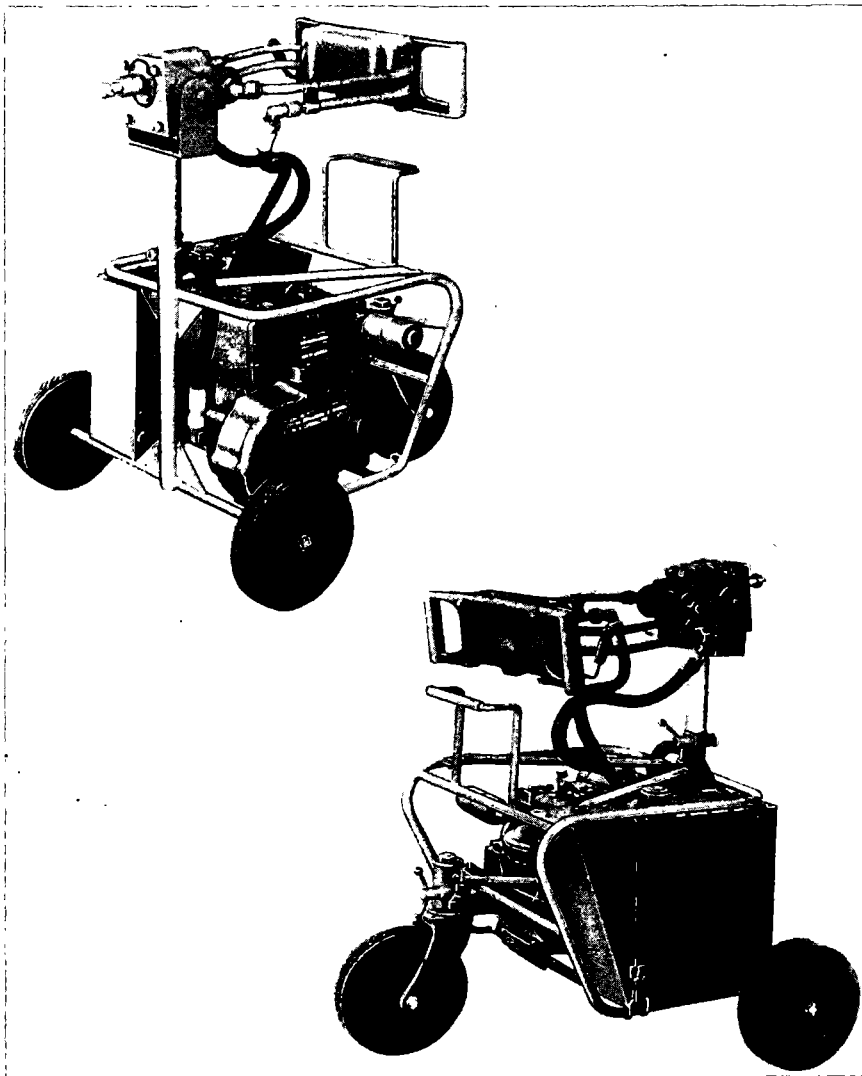


Figure 27. Hydraulic engine starter.

12. Launch Area Equipment

The following equipment is normally located in the launch area :

a. Launcher. The launcher (fig. 26) functions as a portable drone launching platform. It consists of two supports mounted on a tubular steel frame which form a tripod mount. The drone rear support is adjustable for launch angle positions of horizontal, 5°, 8°, 10°, and 12°. The rocket motor firing junction box, aft of the forward support, is electrically connected to an arming switch

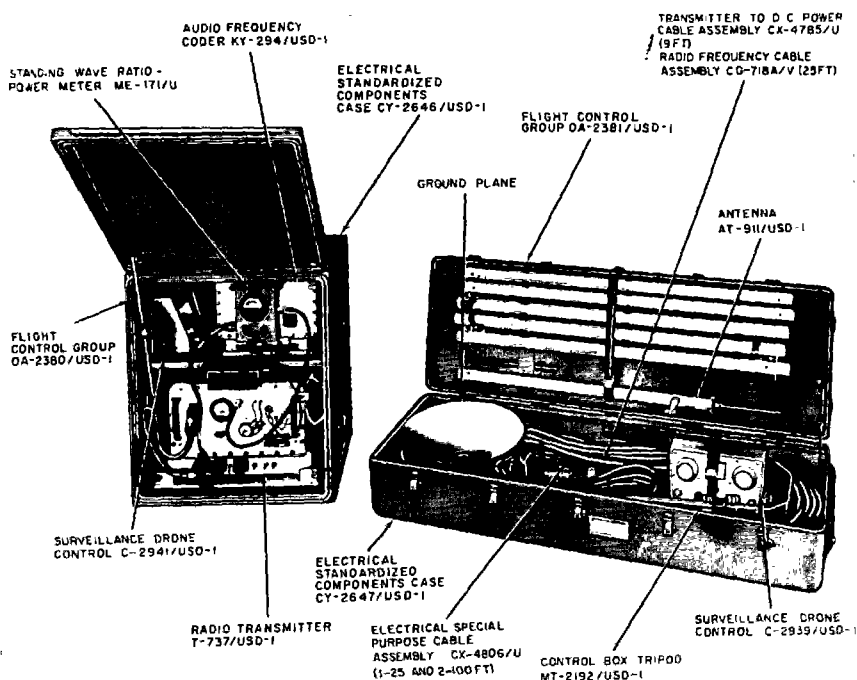


Figure 28. Ground control station packed for transport.

which is actuated manually by a lanyard. A stop latch and shear pin on the rear support prevents drone takeoff before rocket motor firing. (See TM 11-5895-246-12 for operation.)

b. *Hydraulic Engine Starter* (fig. 27). The starter cart consists of four major assemblies: an internal combustion engine and drive assembly, a hydraulic pump and reservoir assembly, a hydraulic motor and 4-way valve, and a tubular steel frame and tricycle wheel assembly. The hydraulic motor is mounted on an adjustable vertical support shaft which telescopes into a hollow shaft on the front of the cart. A locking handle allows the shaft to be locked at any necessary height to engage the drone propeller hub. A pin on the hydraulic motor shaft engages with slots in the drone propeller hub. Handgrips are used to maneuver the starter cart when engaging the starter dog with the drone propeller. When the operating handle is depressed, the hydraulic fluid flows through the hydraulic motor. The motor spins the starter dog and drone propeller. (See TM 11-5895-246-12 for details and operation.)

c. *Ground Control Station* (fig. 28). There are two complete portable ground control stations in the drone system. One ground control station is always situated within or near the launch area.

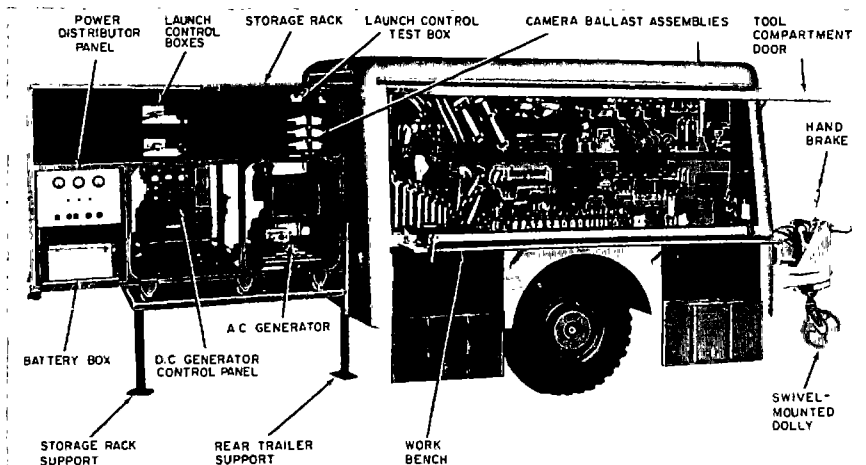


Figure 29. Launch area trailer, right side.

The other is carried on a $\frac{1}{4}$ -ton, M100 trailer, and functions as a standby unit normally located at the radar site for out-of-sight missions. Both ground control stations are designed so that the components are carried in two cases, the transmitter case and the accessory case, and can be transported in any type of vehicle. The transmitter case contains the micromatch meter, transmitter, coder, and master flight control box and is removed from the vehicle for operation of the equipment. The accessory case is used to stow the flight control box, transmitter antenna, control box tripod, transmitter output cable assembly, flight control cable assemblies, control station power cable assembly, antenna mast, ground plane, and the mast mounting brackets. Power to operate the station is supplied by the dc generator in the launch area trailer. Power to operate the standby or second ground control station is mounted in the $\frac{1}{4}$ -ton, M100 trailer (*g* below). (See TM 11-5895-246-12 and TM 11-5821-215-12 for operation.)

d. Launch Area Trailer (figs. 29 and 30). The launch area trailer has storage space for spare parts, tools, and test equipment necessary to perform first and second echelon maintenance on the drone and related ground support equipment. Power unit PE-75AF supplies alternating current (ac) power to operate the launch area test equipment. Power unit PU-465/U supplies direct current (dc) power to operate the drone electrical system, test equipment, and ground control station.

- (1) A cabinet mounted on a trailer chassis contains stowage compartments for handtools, electrical test equipment, and repair parts. A compartment in the front of the cabinet is used for storing spare parachutes. The rear

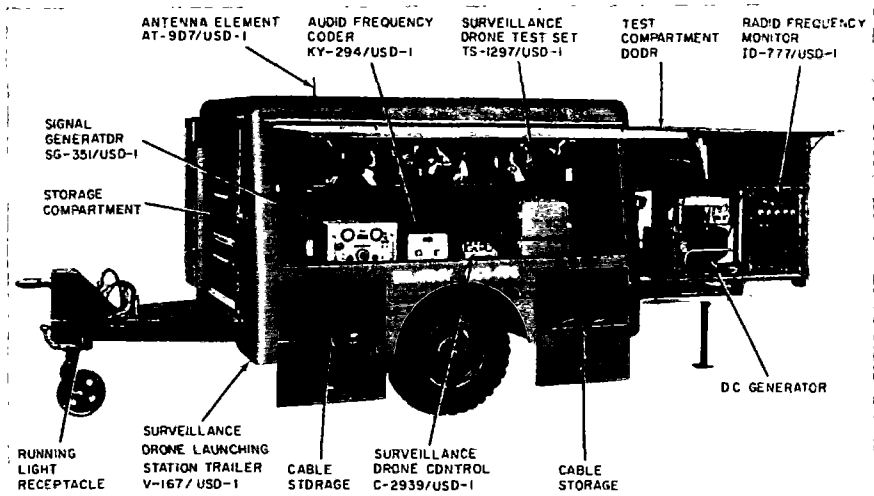


Figure 30. Launch area trailer, left side.

door opens downward and has a platform which supports a telescoping storage rack. The door contains a ground support leg which is adjustable to the proper height to maintain the rear door in a horizontal position. A support leg at the rear of the trailer is used to support the rear of the trailer.

- (2) In use, the storage rack is pulled out on the rear platform to the fully extended position. The rack contains compartments for stowage of repair parts, servos, receivers, propellers, rocket motor carriers, and other miscellaneous drone components. The rack also contains the PE-75AF power unit, a control panel, a signal monitor, and the dc generator. The output of the ac power unit is 2,500 watts maximum, at 115 volts, 60 cycles. The output of the dc generator is 3,000 watts maximum, at 30 volts.
- (3) Most of the necessary cables for connecting the electrical components (of the launch area trailer and the launch area) are stored in the trailer stowage racks.

e. *Drone Transporter* (fig. 31). The drone transport vehicle consists of a 2½-ton, M36C truck, modified to accommodate a drone transport rack, wing transport racks, a radar pod rack, and a hoist assembly. The drone transport rack is installed in the center section of the vehicle and provides for transport and stowage of three drone fuselages. The wing racks are mounted on the left and right sides of the vehicle and are used to transport four complete wing assemblies. The radar pod storage rack is mounted on

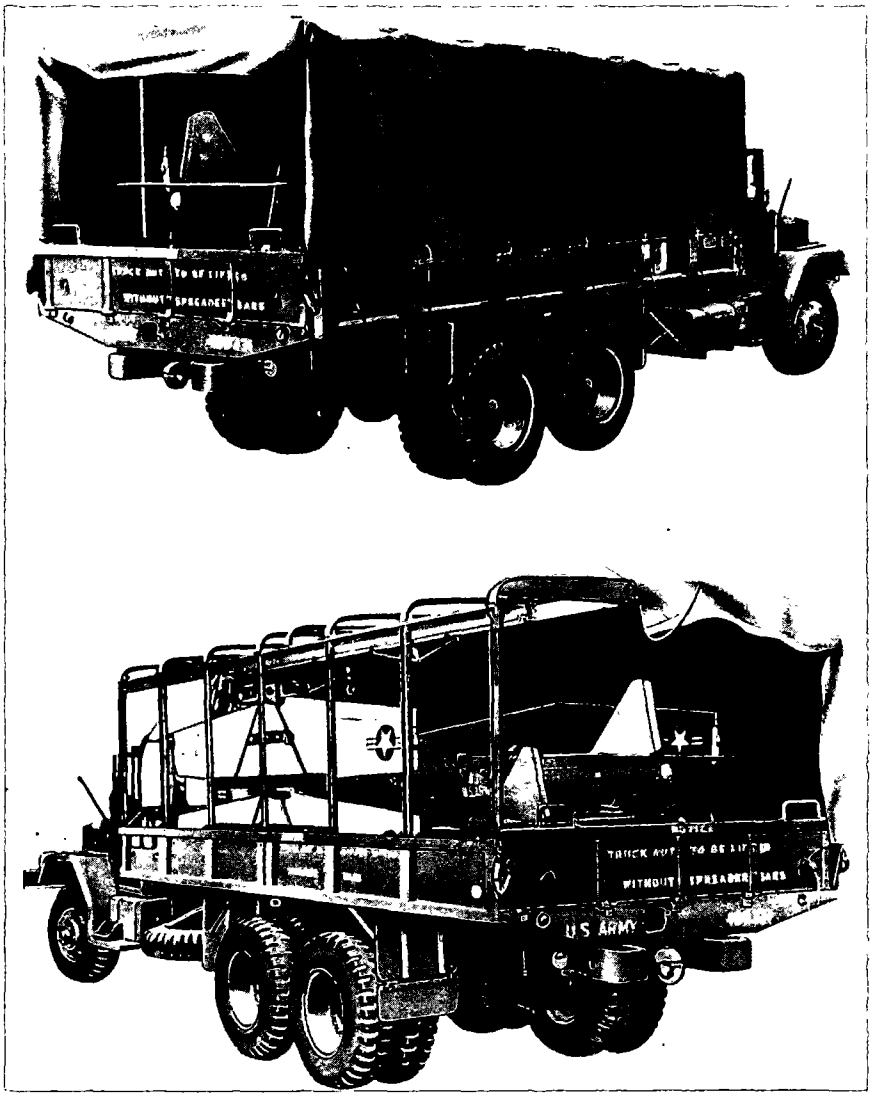


Figure 31. Drone transporter.

the forward end of the vehicle bed and is used to transport six radar pods. An electric hoist assembly on a track running lengthwise in the center of the vehicle is used for loading and unloading drones from the vehicle.

f. *Fuel Supply Unit* (fig. 32). The fuel servicing unit is a fuel-oil mixture supply unit mounted on a welded steel frame bolted to a $\frac{1}{4}$ -ton, M100 trailer. It consists of a 32-gallon fuel tank, fuel transfer pump, mixture agitator, filter, fueling hose reel, fueling

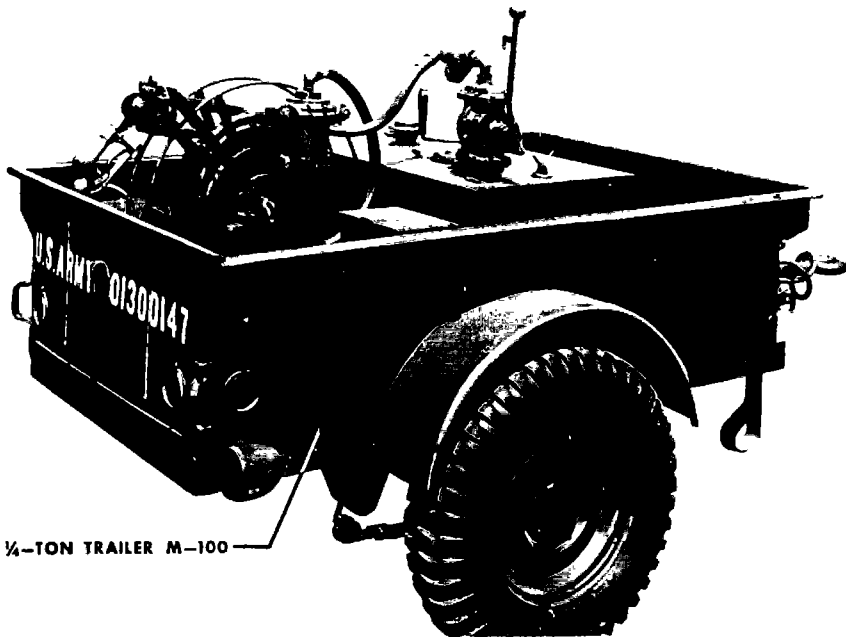


Figure 32. Fuel supply trailer.

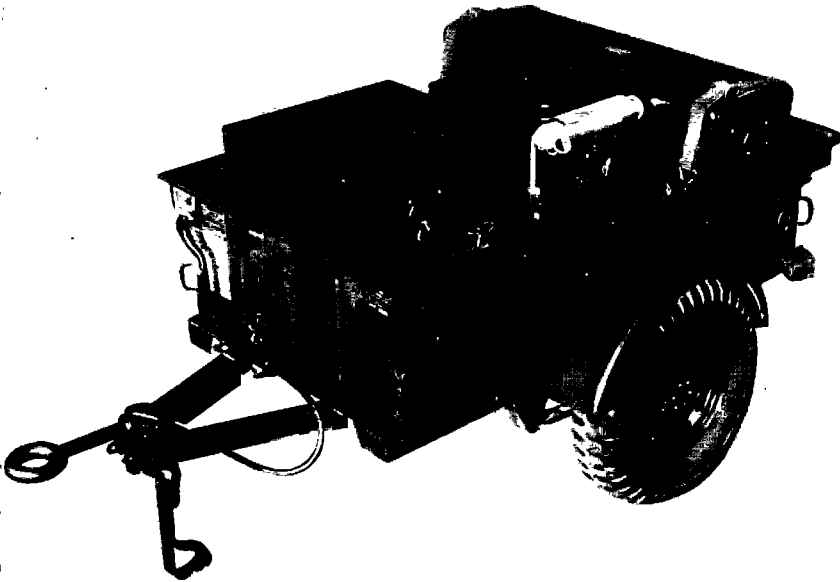


Figure 33. Trailer-mounted ground control station.

hose and nozzle, filler cap, and drain valve. Its function is to transfer the fuel-oil mixture from the fuel servicing unit to the drone.

g. Trailer-Mounted Ground Control Station (fig. 33). The trailer-mounted ground control station is a self-contained unit. It consists of a transmitter case and accessory case containing ground station components, a PU-465/U power unit, a waterproof storage box, and a reel of communications wire mounted on a 1/4-ton, M100 trailer. Ground control station repair parts and telephone set TA-312/PT are contained in a waterproof box mounted under the accessory case.

Section II. COMMUNICATIONS

13. Radio

Radio is the primary communication means for the drone section except when drone prelaunch and launching procedures are being carried out.

a. Command Net (FM-Voice). All elements of the drone section will operate in the section command net (FM) controlled by the section commander. During drone flight operations, one or both tracking and plotting radar units will join the net (fig. 34). Mounted FM radio equipment is provided the section commander for communications in both the section command net (FM) and the aerial surveillance platoon net (FM). When the drone section is attached to other units, it can enter the command net (FM) of a supported unit by leaving the platoon net.

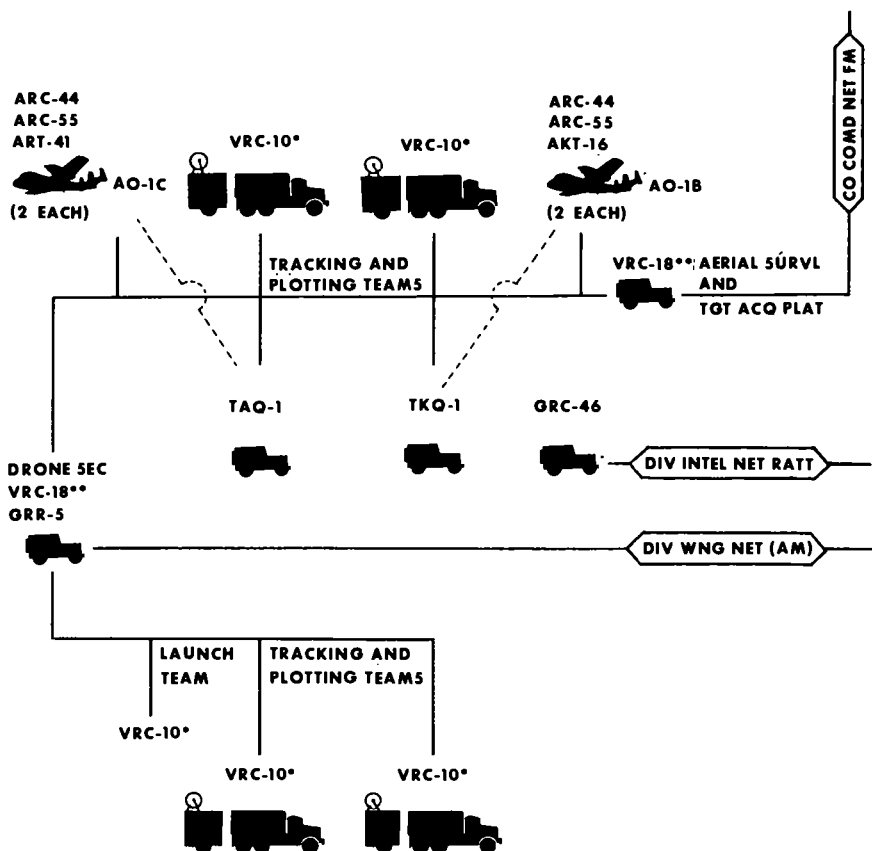
b. Control Net (UHF). The control net (UHF) provides flight control for the drone. The drone uses a frequency between 406 and 420 megacycles. There are two ground control stations; however, only one ground transmitter and one drone can be operated on the same frequency at the same time.

c. Division Warning Broadcast Net (AM-Voice). This net is used to broadcast air alert; chemical, biological, and radiological operations; attack warning (CBR); fallout warning; rad-safe-data; nuclear strike warnings; and similar information of an urgent operational nature. The section is equipped with the AN/GRR-5 radio receiver to monitor transmission over this net.

d. Division Intelligence Net (RATT). This net is used primarily for transmission of intelligence information, but it may be used to transmit command or logistic message traffic if those nets become inoperative or overloaded.

14. Wire

a. General. The initial *wire system* installed for various tactical



NOTE: ----- DATA LINK

*VRC-10 OR 8
**VRC-18 OR 16

Figure 34. Radio net.

situations is limited by time and by the amount of wire and personnel available. Communication within the drone launching complex should, wherever possible, be conducted by wire to provide maximum transmission security. The wire net (fig. 35) consists of nets within the launch and maintenance areas.

b. Installation. When time permits, wire may be installed between the various elements of the drone section and the tracking and plotting section to supplement or replace radio. Wire should be installed between the elements of the drone section and the supported organizations whenever possible.

c. Employment. The drone section is tactically employed in two areas—the forward drone launching area and the maintenance

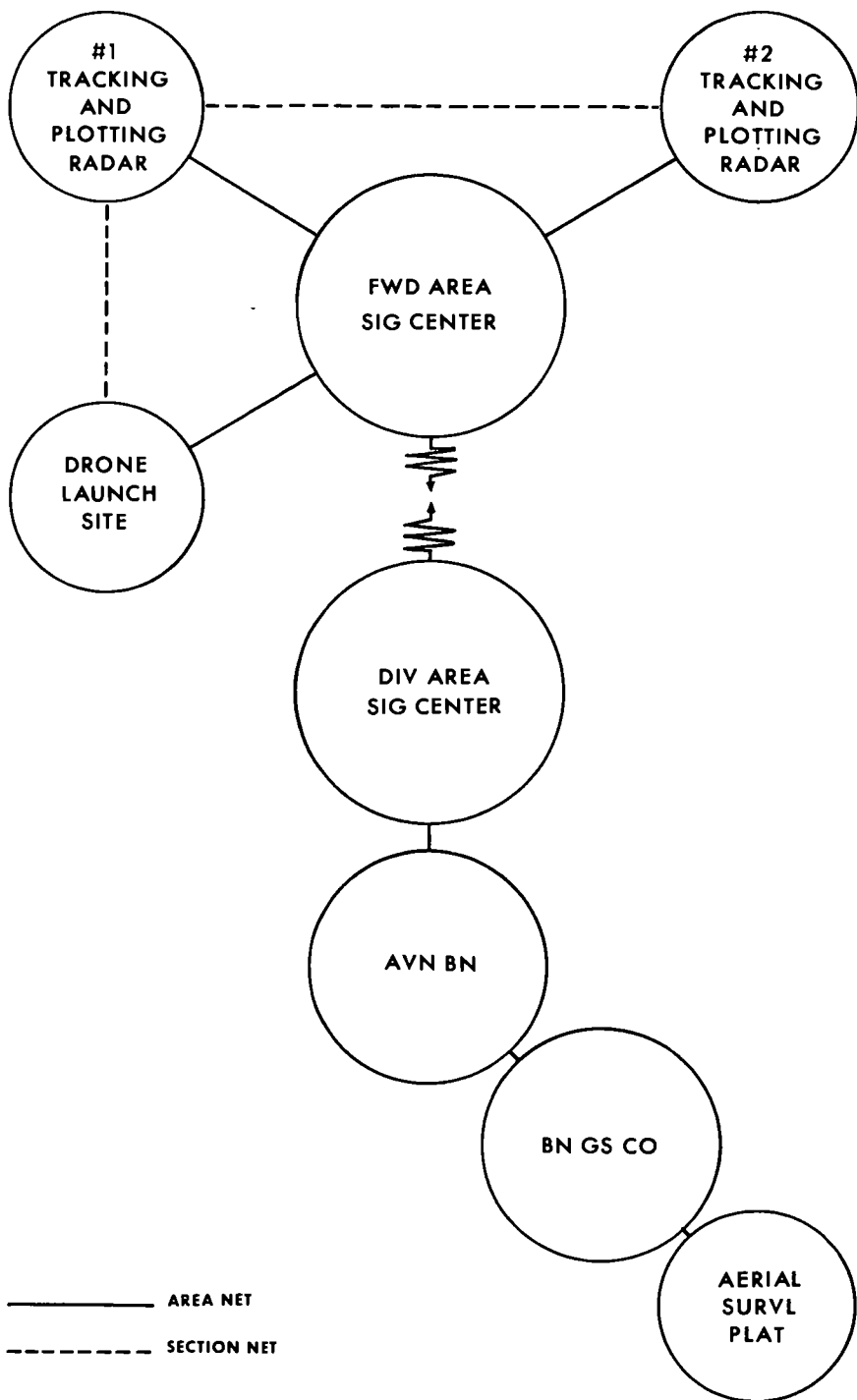


Figure 35. Wire net.

area. Application of wire communication is considered separately in each area.

- (1) In the forward area, a wire circuit should be provided between the drone launch team and the supporting tracking and plotting radar. The supporting tracking and plotting radar is considered the most static element close to the launch areas. It should receive the highest priority in establishing communication into the division forward area communications system. Both tracking and plotting radars require a direct wire circuit between them to facilitate rapid transfer of tracking missions during normal operations and emergencies.
 - (a) The launch team should also have access to the division area communications system either through an adjacent unit switchboard or directly into the forward area signal center.
 - (b) Alternate launch sites may be prewired to facilitate rapid communications.
- (2) When the drone maintenance area is placed near but not with drone launching elements, it will be located with or in the immediate vicinity of a unit capable of augmenting its security and communication capabilities. For additional information about communications, see FM 11-50.

15. Other Communication

Visual, audio, and messenger communication means are used in the same manner as in other organizations. For additional information, see FM's 7-24, 17-70, and 21-60.

CHAPTER 4

FLIGHT PREPARATION AND LAUNCHING PROCEDURES

Section I. LAUNCH AREA OPERATIONS

16. Launch Site Selection

a. General. The launch site (fig. 36) should be located near the FEBA to exploit the range of the drone; however, the drone may be launched from a rear area and control transferred to a forward controller. Ultimate selection of the launch site will depend primarily on the tactical situation. Maximum view of airspace in all directions is desirable. Almost any unimproved area (wooded, rocky, hilly, etc.) can be used provided equipment can be moved into it.

b. Selection Factors. The primary consideration in launch site location is to provide the drone with an adequate range over enemy territory to cover the unit's area of interest and influence. This may require the selection of several sites. The launch site selected must be as close to the FEBA as possible commensurate with the tactical situation, security requirements, and drone capabilities. Launch sites should be in defilade where possible. A clear line of sight to the anticipated drone flight pattern is only necessary when the AN/MPQ-29 radar is located at or near the launch site. *The flash, dust, and smoke that accompany drone launching should be concealed from enemy observation. The masking effect of terrain can accomplish this by day or night, while distance will conceal daylight launching.* Equipment must be placed in the launch area within the limits of all interconnecting cables. Important factors in the selection of a launch site are—

- (1) Cover and concealment.
- (2) Accessibility to a road net.
- (3) Terrain that permits launching of the drone in a desirable direction with obstruction clearance.
- (4) Presence or absence of terrain mask.
- (5) Avoidance of interference with friendly troops or installations.

c. Alternate Sites. Sufficient alternate launch sites are pre-selected to enable the launch team to change locations as frequently as required by the tactical situation. This may require moving to a new location after each launch.

d. Security. When the drone section operates from forward launching sites, security will be furnished by the supported unit or, if in general support, by a designated unit.

1. DRONE ON ZL-3 LAUNCHER
2. HYDRAULIC ENGINE STARTER
3. LAUNCH AREA TRAILER
4. LAUNCH SITE CONTROL STATION
5. DRONE TRANSPORTER
6. FUEL SUPPLY TRAILER
7. ORDNANCE STORAGE AREA
8. FORWARD RADAR AND CONTROL SITE

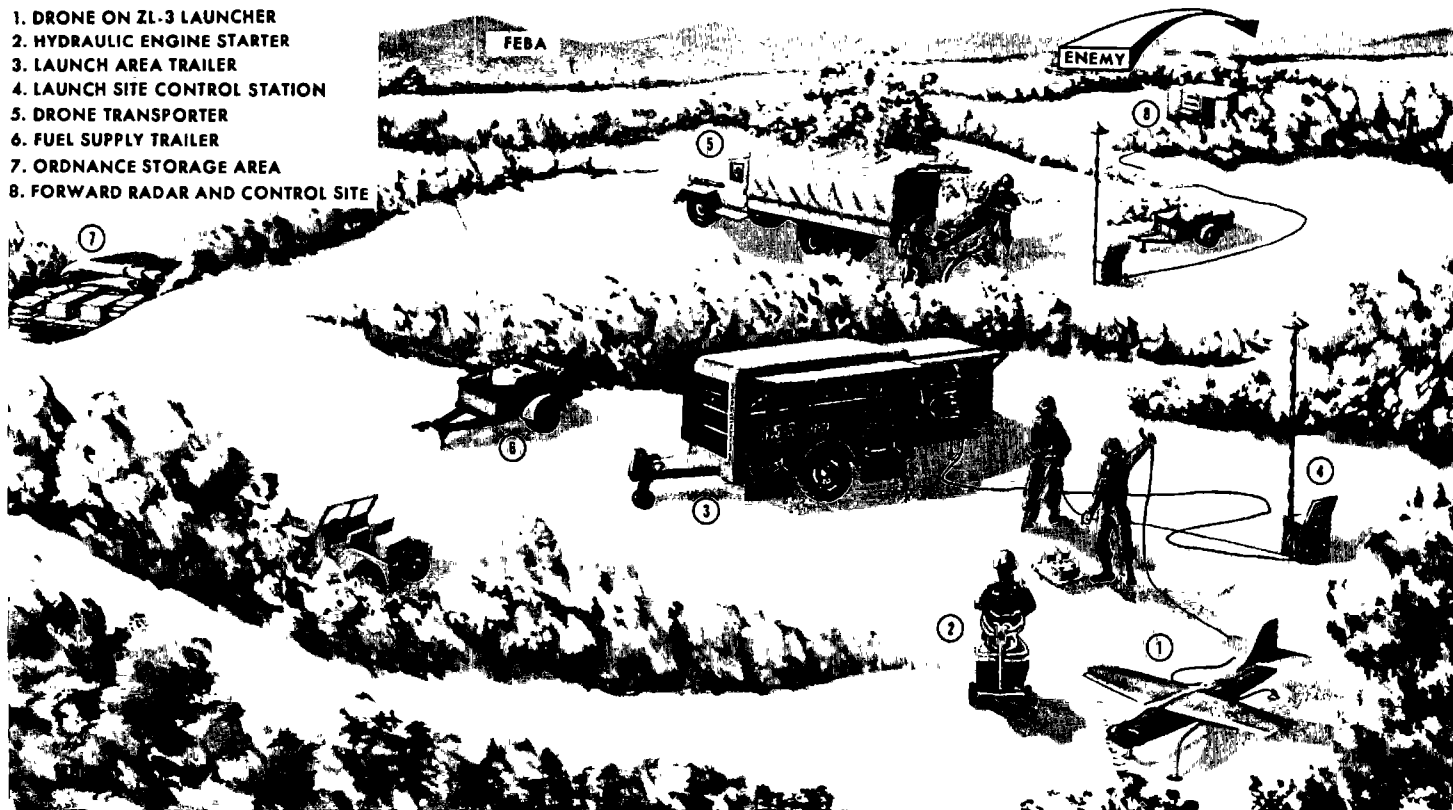


Figure 36. Typical launch area.

17. Equipment Placement and Preparation

a. *Launcher.*

- (1) *General.* Arrangement of the launch area is governed by the placement of the launcher; therefore, the launcher should be positioned first. The launcher position should provide ample clearance for drone takeoff. Preferably the launcher should be placed so that the drone is launched into the wind. The drone must clear all obstructions as outlined in (2) below. The horizontal section of the launcher should be nearly level when the legs are set on the ground. The area immediately adjacent to and in front of the launcher should be level enough to accommodate the starter cart. Location of the launcher will determine the safety area where all other equipment must be placed during launching. (For details on launcher adjustment and operation, see TM 11-5895-246-12.)
- (2) *Obstruction clearance.* The drone can be launched at 0°, 5°, 8°, 10°, and 12° launch angles. The setback required for minimum and maximum degree launch angles to clear obstructions is shown in figure 37. Launcher setback from any obstruction is determined by estimating the height of the obstruction and applying the estimated height to the launch angle. Lowest launch angle should be used whenever possible to permit the drone to gain airspeed rapidly, resulting in a smoother, more dependable launch. Use of lowest possible launch angle will aid, to some extent, in concealing the launch position.
- (3) *Danger zone.* The danger zone (fig. 38) in the launch area is the area within 15 meters of either wingtip, 60 meters of the tail section, and 300 meters in front of the drone when installed on the launcher. All equipment except the hydraulic starter must be located outside of the danger zone. During rocket motor firing, the safety area provides a safe distance for operating personnel. The terrain immediately to the rear of the launcher must be cleared of any sticks, small rocks, glass, etc. to prevent missile effect into the safety area during launch. Immediately upon launch, the rocket motors and carriers drop off, impacting 200 to 300 meters forward of the launcher. Friendly troops should not be permitted within 450 meters forward of the launcher.

b. *Launch Area Trailer.* The placement of the launch area trailer is restricted by the length of the interconnecting cables between the launch area trailer and launcher. The trailer should

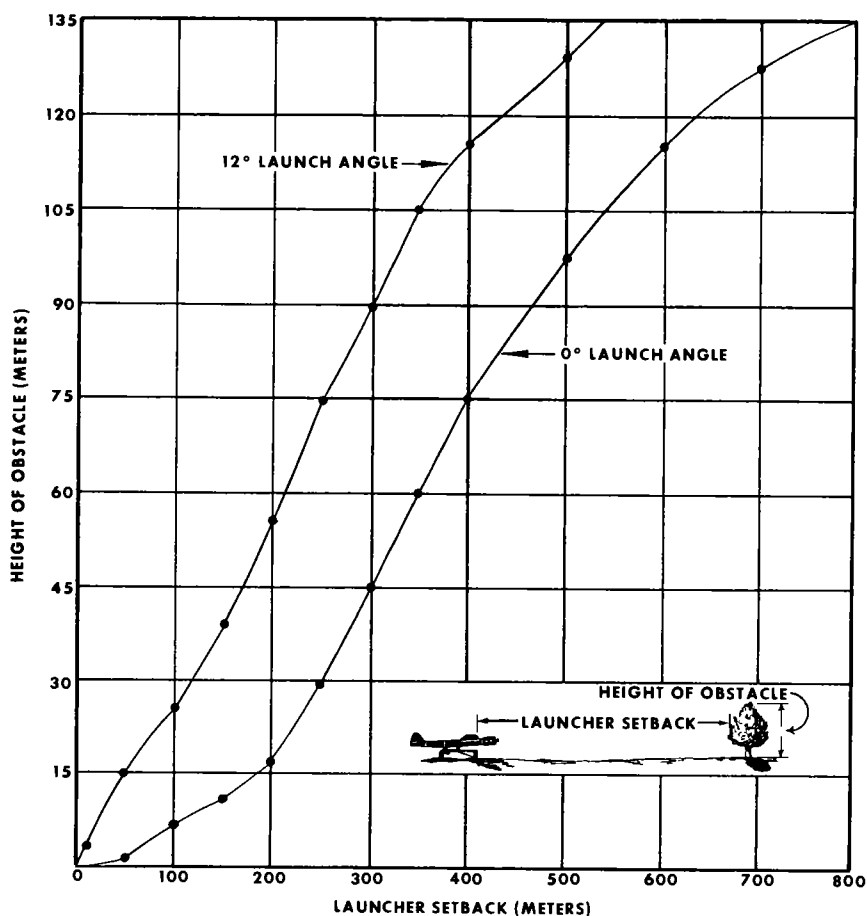


Figure 37. Launcher siting and altitude chart for 0° and 12° launch angles.

be placed where it will be readily accessible to the launch crew, preferably off the left wingtip, in order to aid personnel in carrying out an efficient launch operation. It must be located in the safety zone. In a semipermanent launch site, two launchers should be employed with the launch area trailer between the launchers in the safety area. (For details of preparation and operation, see TM 11-5895-246-12.)

c. *Hydraulic Engine Starter.* The starter cart should be placed near the launcher so that it will be readily available for starting the drone engine. After placement, check the quantity of engine fuel, oil, and hydraulic fluid. The gasoline engine should be started and the starter operations checked out. (For details of operation, see TM 11-5895-246-12.)

d. *Drone Transporter.* The drone transporter should be located

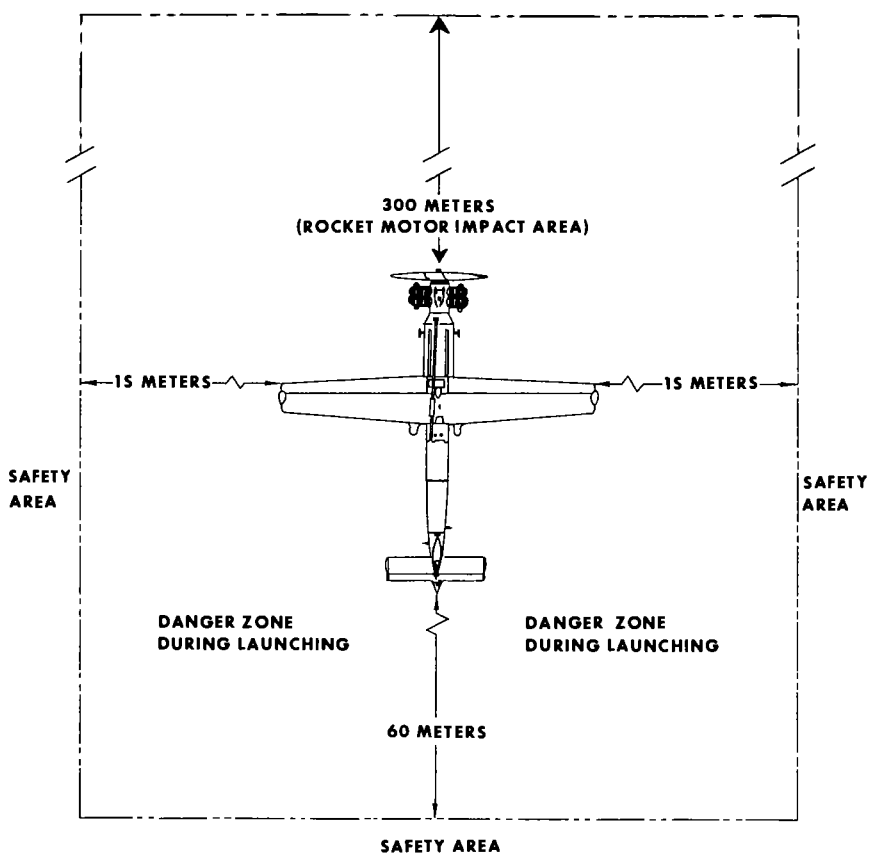


Figure 38. Danger zone.

near the launch area for ease in transferring drones from the vehicle to the launcher or dolly. Placement of the vehicle will be in the safety area where it will not interfere with the launching operation. Normally, the transporter will carry one starter cart, one launcher, one launcher mat, three drone fuselages, four drone wings, and three pairs of radar reflector pods. Extreme care must be taken during all unloading operations. The top center drone must be unloaded prior to unloading the additional equipment. (For details, see TM 11-5895-246-12.)

e. Fuel Supply Trailer. The fuel supply trailer should be placed on the same side of the launcher as the launch area trailer and must be approximately 150 meters from the launcher. All excess fuel and oil should be stored near the fuel supply trailer to facilitate fuel mixing and proper storage and handling procedures. A $\frac{1}{4}$ -ton truck will pull the fuel supply trailer to the drone when fueling is required.

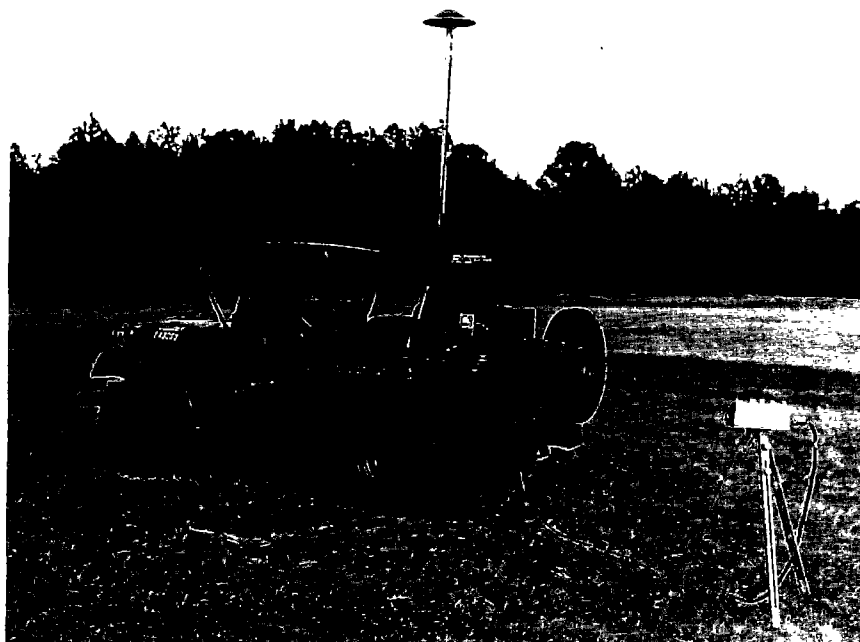


Figure 39. Ground-control station mounted in 1/4-ton truck.

f. Ground-Control Station. Two or more ground-control stations can be used effectively to cover a large flight area by shifting control as required by the terrain and mission. Only one ground-control station can be operated at the same time on the same frequency. A flight might originate in a rear launch area and control of the flight can be shifted to the forward controller located at the tracking radar site. Finally control could again be shifted to the rear area controller (possible in a different location) for recovery purposes. Possible locations and arrangements for ground-control stations are—

- (1) *Launch site.* Whenever possible, one ground-control station should be located at or near the launch site for all launchings. The control station must be placed within 6 meters (for cable connection) of the dc generator mounted in the launch area trailer.
 - (a) Figure 39 shows the ground-control station mounted on a 1/4-ton truck: removal from the truck is optional at the launch site. The mounted ground-control station can use the truck's generator as an alternate power source. (Coders must be aligned on 24 volts when using truck generator.)

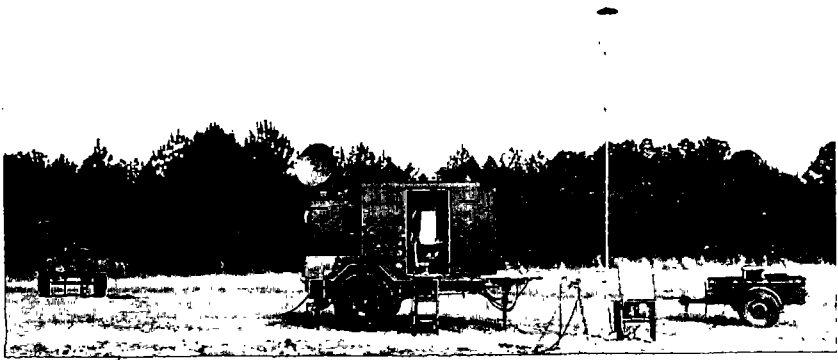


Figure 40. Trailer-mounted ground-control station at radar site ready for use.

- (b) Normally the control station at the launch site will be used for in-sight flying. If the control station at the launch site is using power from the dc generator on the launch area trailer, the AN/MPQ-29 radar must be located approximately 30 meters from the launch area trailer. It is desirable to avoid concentration of equipment in one area; therefore, the AN/MPQ-29 radar should be at least 300 meters (line-of-sight) from the launcher. The ground-control station at the radar site uses an independent power source; e.g., a truck's generator.
 - (c) Provided line-of-sight is possible, successful launches can be made using only one ground-control station located up to approximately 3,000 meters from the launcher. However, this type of operation should be used only in an emergency since it increases delay in controller response when instant recovery may be required to prevent losing the drone on launch. Radio and telephone communications are required when the ground-control station controlling the drone on launch is more than 300 meters from the launcher. On all launches, the second ground-control station should be warmed up and ready to transmit should the controlling station fail during the mission.
- (2) *Tracking radar site.* The second ground-control station will normally be located at the tracking radar site (par. 26a(1)) for out-of-sight flying. This control station should be the portable ground-control station mounted in the $\frac{1}{4}$ -ton trailer. This control station operates in conjunction with the AN/MPQ-29 radar and can be

placed at considerable distance from the launch area. Typical arrangement of this station is shown in figure 40. (For details of preparation and operation, see TM 11-5895-246-12 and TM 11-5821-215-12.)

g. Ordnance Storage Area. The ordnance storage area (fig. 41) must be constructed each time a launch site is to be used two or more times. Construction will be of sandbags or will be an entrenchment located at least 150 meters from the launcher. Rocket motors, photoflash cartridges, squibs, and ammunition will be placed on dunnage in order to keep them dry and provide for air circulation. The ordnance storage area is covered by two thicknesses of tarpaulin as shown in figure 41. Use extreme care when handling and storing the rocket motors. (For details of storage and handling, see TM 9-1900 and TM 9-1955-1.) Gasoline must not be stored in the ordnance storage area and no smoking is permitted within 15 meters.

18. Initial Drone Preparation

a. Initial Preparation. The drone is completely assembled prior to transporting to the launch area except for the wing, gyro, parachute, drogue gun, camera, transponder beacon, and rocket motors. On arrival in the launch area the drone is removed from the transporter and placed on a dolly; if this is to be a rapid launch, the drone is placed on the launcher instead of the dolly. To perform the various test and installations on the drone, the dolly is moved to a convenient location near the launch area trailer. Except for the rocket motors, the above mentioned components will normally be installed while the drone is on the dolly.

b. Electronic System Checkout. While the drone is mounted on the dolly, the electronic system checkout (fig. 42) is made using the surveillance drone test set TS-1297/USD-1. (For test set operation, see TM 11-5895-249-12.) Before the checkout can be started, the gyro and wing must be installed. (For component installation and checkout procedure, see TM 11-5895-246-12.) The test set will indicate GO by green lights or NO-GO by red lights. All components indicating NO-GO can immediately be corrected. Test set TS-1297/USD-1 may give inaccurate GO-NO-GO indications. For this reason a visual checkout of the drone should be conducted in conjunction with the TS-1297/USD-1 checks. The control system and airframe and engine preflight checklist should be taped to the vertical stabilizer and each item checked as they check-out on the test set. (For suggested checklist, see app. II.) Upon completion of the electronic system checkout all components of the drone should be ready for launch except the camera and transponder beacon.



Figure 41. Ordnance storage area.

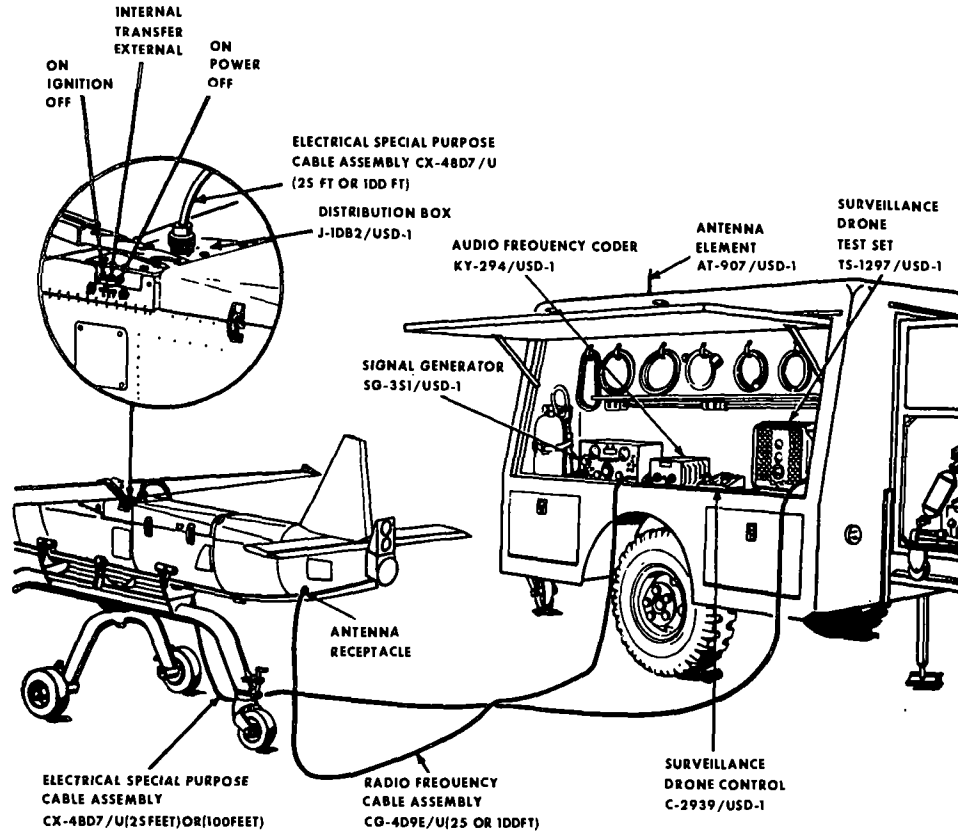


Figure 42. Electronic test checkout.

c. Parachute Installation. Installation of the parachute into the drone parachute compartment is one of the most important steps on drone preparation. An airframe and engine mechanic will usually make the installation.

- (1) The parachute is prepacked in the maintenance area:
 - (a) It is packed inside a paper parachute packing bag placed inside a wood packing box. The packing box is the same size and shape as the drone parachute compartment and is used to store packed parachutes to protect them from damage.
 - (b) The parachute, packed in the paper parachute bag, is taken from the packing box and installed in the drone. (For details of parachute installation into the drone, see TM 11-5895-246-12.)
- (2) The last portion of the parachute installation includes installation of the quick release device (squib assembly); extreme caution must be taken when installing the high-explosive squibs. Upon completion of the installation the parachute compartment door is closed and secured with a retainer strap.

Caution: Parachute will not function properly if instructions contained in TM 11-5895-246-12 are not complied with.

d. Drogue Gun Installation. The drogue gun fires a cartridge which propels a 1/2-pound projectile the instant the chute command is given by the ground controller. This projectile extracts the pilot chute which in turn extracts the main chute clear of the vertical stabilizer.

- (1) The drogue gun lanyard is attached to the stirrups on the pilot parachute during the last step of parachute installation. The other end of the lanyard attaches to the drogue gun projectile. The projectile and cartridge are loaded and the drogue gun installed in the drone. (For details of installation, see TM 11-5895-246-12.)
- (2) The drogue gun contains a high explosive cartridge and must be handled with extreme care.

Warning: The safety pin must not be removed from the firing mechanism of the drogue gun until just prior to launching the drone.

e. Camera Installation and Checkout. The AN/USD-1 drone uses three camera configurations: KA-20A camera (day only), KA-39A camera (day or night), and the KS-53A camera system. The KS-53A camera system is composed of the KA-39A camera, photoflash cartridge ejectors (left and right), and photoelectric

cell. Installation of all three configurations vary, therefore are discussed separately:

- (1) The KA-20A camera has a day capability only. This camera requires the use of a venturi tube to provide its vacuum source. The preliminary preparation of the camera should be performed by the photographic personnel if available. If such personnel cannot prepare the camera, preparation becomes the responsibility of the drone section. Two control system mechanics should be delegated the responsibility of handling and preparing all cameras used by the section. (For details of installation and checkout, see TM 11-6720-203-10.)
- (2) The KA-39A camera is a component of the KS-53A camera system. All components of this system are not used when the KA-39A camera is used for day photographic reconnaissance. This camera has a built-in vacuum motor and does not require use of a venturi tube. Therefore, the tube should be removed from the drone fuselage when using this camera. (For details of installation and checkout, see TM 11-6720-207-10.)

Caution: Lead ballast must be installed in the drone if it is to be flown without the camera. Failure to install the ballast will cause pitch control difficulties and may result in loss of the drone.

- (3) KS-53A camera system with all components is used primarily for night photo reconnaissance. The photoflash cartridge ejectors, photoelectric cell, and camera control box should be installed in the maintenance area. The camera will normally be installed at the launch area. Due to final installation of all components at the launch area, a final checkout is required using the photoflash cartridge ejector test set. Normally the checkout with the test set should take place in both the maintenance area and launch area. (For details on installation and checkout of KA-39A camera, control box, and all interconnecting cables, see TM 11-6720-207-10.) When all components of the system and the test set have been installed, the following procedures will apply:
 - (a) Apply power to drone system and allow warmup time.
 - (b) Depress breaker on camera control box. Remove Lucite cover from flare arming switch push rod. Manually actuate push rod to engage and allow 10 seconds for switch to arm. (Switch is armed when push rod returns to extended position.) Disengage circuit breaker turning the camera off. From the drone con-

trol box, command camera ON. Synchronize the drone control box with camera operation; command OFF, and both should be in the OFF position. Depress circuit breaker on camera control box. Reset photoflash cartridge sequence relay by pressing reset switch on camera control box until green lamp illuminates.

- (c) Check to be sure camera is set for night mode of operation (night position and 1/150 seconds). Have an assistant, at rear of drone, cover the photocell to prevent exposure to light (during daytime checkout).
- (d) Command camera ON and note the sequence of lights on the photoflash cartridge ejector test sets. They should illuminate right No. 1, left No. 1, right No. 2, left No. 2, etc. As the lights illuminate, the assistant will uncover the photocell and quickly cover it again, causing the camera shutter to close. In daytime if insufficient natural light fails to cause camera shutter to close, use a flashlight shining directly into the photoelectric cell. At night, use a flashlight to trigger the photocell. (Shutter actuation can easily be recognized by the sound it makes. The sound will be emitted from the lens cone.)
- (e) After light left No. 2 has illuminated, immediately command camera OFF. Light right No. 3 should not illuminate, and the camera will shut off. Hold the SALVO switch on the camera control box in the forward position (as mounted in drone). Light left No. 4 should illuminate. Allow the remaining lights to illuminate in sequence and then release the SALVO switch. Press reset switch on camera control box until green light illuminates. Again place the SALVO switch in the forward position; no light should illuminate. If they do, the arming switch is defective and should be replaced.
- (f) Reset camera control box and the camera is ready for flight.

Warning: Failure to disarm the arming switch can result in premature flare ejection and cause serious injury to personnel. Always be sure that the reset switch has been depressed after the checkout is completed.

- (g) Remove the photoflash cartridge ejector test set and the system is ready for photoflash cartridge installation.

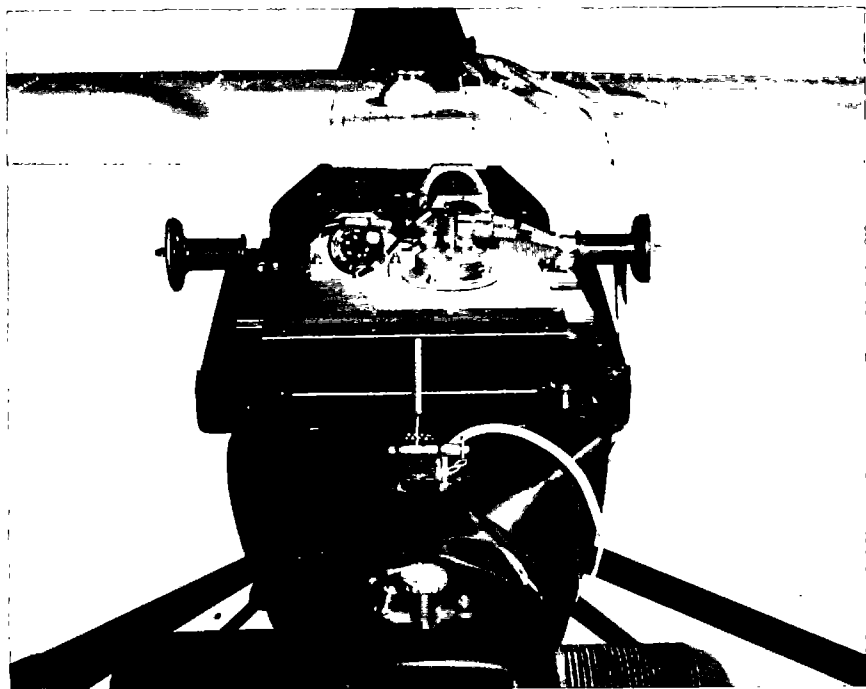


Figure 43. Beacon installation.

Caution: Weight and balance check is required when installing new configurations of equipment (such as night surveillance equipment, KA-20 camera, or AN/DPN-62V transponder beacon). Weight and balance check procedures in TM 11-5895-246-12 must be complied with.

f. Beacon Installation and Checkout. The AN/DPN-62V transponder beacon and two scimitar antennas are mounted on a beacon mounting board in the maintenance area. The third required scimitar antenna and necessary cabling is issued with each drone and is mounted on the rear of the aft fuselage section (fig. 17). In the launch area, the beacon mounted on the board (fig. 43) is installed on top of the camera compartment. After all cables are connected the beacon must be checked out using the AN/URM-125 transponder beacon test set. (See TM 11-6625-392-12.) The checkout determines if the transponder beacon will respond efficiently at maximum range to interrogation pulses received from the associated radar tracking unit. Receiver sensitivity, transmitter power output, transmitter frequency, and duplexer and antenna performance are checked. The beacon is ready for use when all checks are successfully completed.

Caution: A weight and balance check should be made when flying the drone without the transponder beacon.

Section II. MAINTENANCE AREA OPERATIONS

19. Maintenance Site Selection

The maintenance site may be located near other elements of the aerial surveillance platoon at the aviation battalion airfield or supported unit's rear elements. Normally the maintenance site should be located in a centralized position in the general vicinity of, and readily accessible to, the proposed launch site. When selecting the maintenance area site, the following must be considered:

a. Ready access to all-weather roads suitable for transport of equipment to the maintenance area and from the maintenance area to the launch area.

b. The terrain must provide seclusion from enemy observation. The maintenance area should be flat, well drained, free of obstructions, and have adequate room for all maintenance equipment.

c. Parking space must be provided for repair-parts vehicles in a location readily accessible to maintenance personnel, and for maneuvering drone transport vehicles delivering drones to and from the launch area.

20. Equipment Placement and Preparation

a. *Maintenance Tent.* The maintenance tent (fig. 44) is the focal point of the maintenance area. Loading and unloading areas adjacent to the tent are desirable to facilitate movement of items to and from the tent. The tent is the largest single item in the maintenance area; therefore, it should be located under or next to any natural concealment (such as trees or rocks) to prevent detection by enemy reconnaissance. The equipment used in the maintenance tent can be arranged in any manner that will afford maximum working space. Figure 22 illustrates one suggested arrangement which can be varied to the requirements of maintenance personnel. The engine mounting bench and the bench grinder should be placed at opposite corners of the tent to prevent grinder abrasives from entering a disassembled engine. (For more details, see TM 11-5895-246-12.)

b. *Mounted Electronic Maintenance Shop.* The electronic maintenance shop (fig. 45) will be logically situated for testing and repairing items with the least moving or handling if located adjacent to the final assembly end of the maintenance tent. A cleared space large enough to accommodate at least one drone

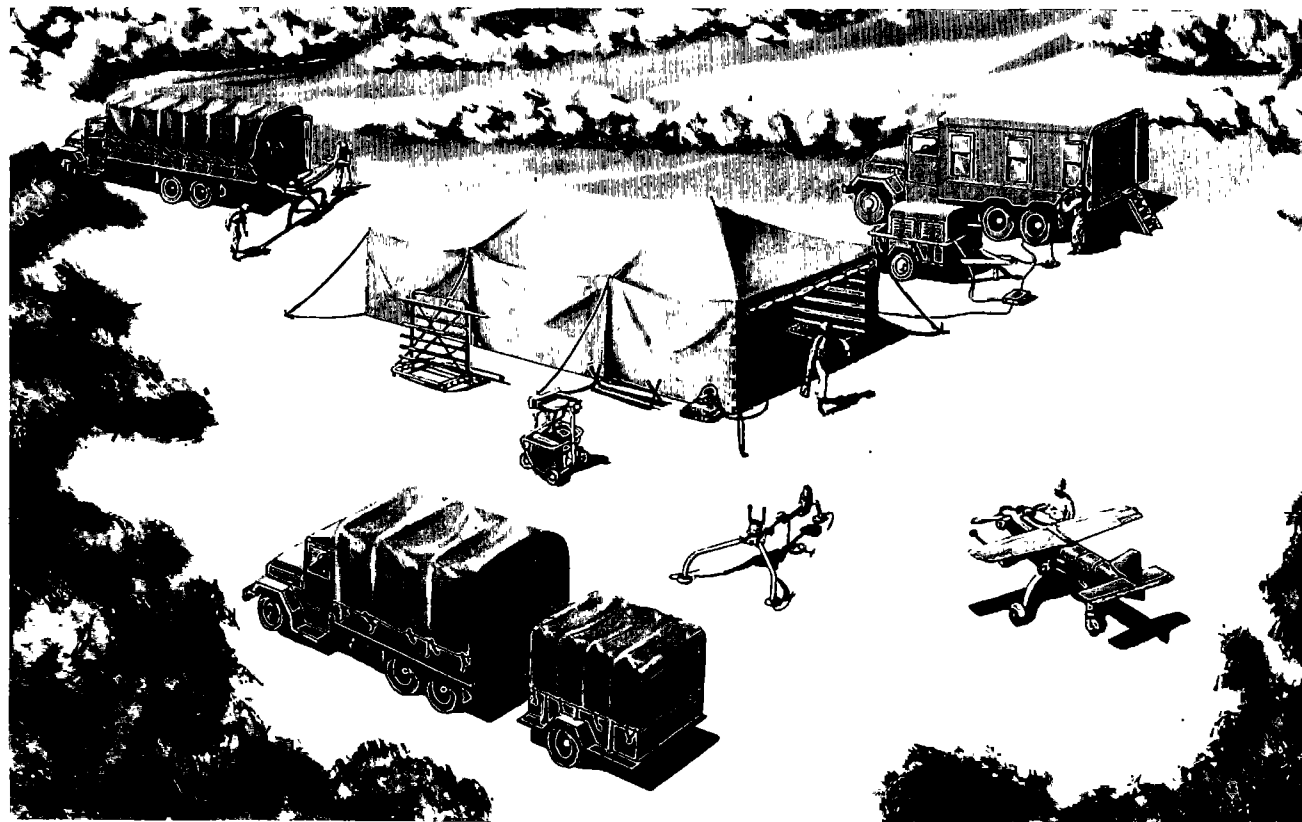


Figure 44. Maintenance area.

should be provided. The PU-290/MR power supply unit furnishes ac power to operate maintenance area equipment. The electronics maintenance shop van is connected by an interconnecting cable from the power supply trailer to a receptacle on the right forward side of the van. From the receptacle and through a power distribution box in the van, ac power is supplied to test equipment, lights, and benches in the maintenance van. The dc generator (PU-465/U), located in the front end of the power supply trailer, is connected by an interconnecting cable to an external receptacle on the left forward side of the van and to outlets in the van for test units.

c. Power Supply Unit. The PU-290/MR power supply unit should be situated between the electronic maintenance shop and the maintenance tent; space must be provided for a drone and a portable handling dolly on both sides of the power unit. All units must be within cable length distance from the power unit. During power unit operation, both ends of the tarpaulin must be open for cooling and ventilation.

d. Spare Parts Vehicle. The spare parts vehicle should be positioned so as to contribute most to the efficiency of the maintenance operations. If practical, locate the vehicle adjacent to the maintenance tent. Positioning is not critical as no power supply cabling is needed to the spare parts vehicle.

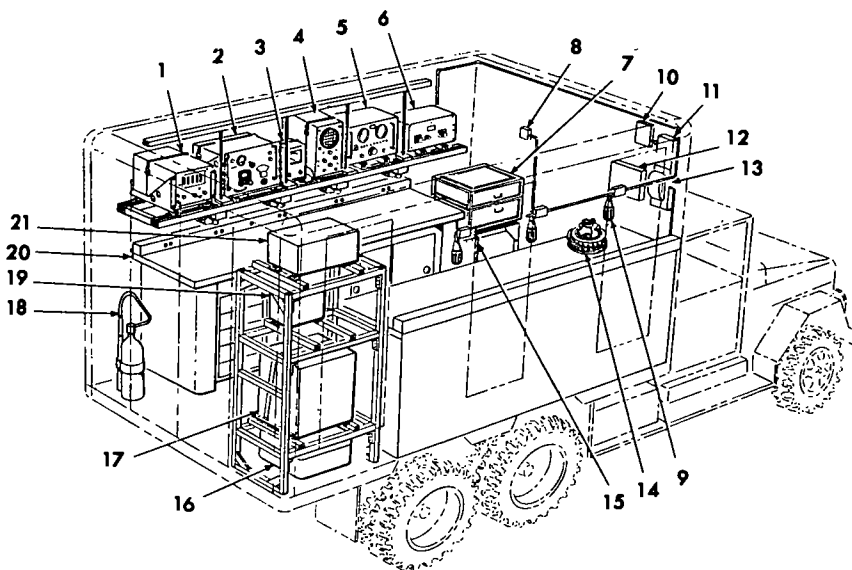
e. Miscellaneous Equipment.

- (1) Miscellaneous equipment includes the drone handling dolly, wing rack, battery charger, etc. These items will be located at the maintenance tent or the electronic shop.
- (2) The parts washer requires special placing and preparation. It should be located in a position readily accessible to the maintenance tent. Once installed, the washer is difficult to move without draining the tank. The washer must be well ventilated at all times to guard against fire hazard.

21. Maintenance

a. Drone. The drone section is capable of performing first through fourth echelon maintenance on the drone. Normally first and second echelon maintenance can be accomplished in the launch area and third and fourth echelon maintenance in the maintenance area. (For details of drone maintenance, see TM 55-1550-200-12 and other applicable TM's.)

b. Launch Area Equipment. First and second echelon maintenance is performed as applicable on the launcher, hydraulic starter, fuel supply unit, launch control box, launch area trailer,



2½-TON 6 × 6 SHOP VAN TRUCK M-109

- 1 FREQUENCY METER AN/TSM-16**
- 2 FREQUENCY METER AN/URM-81**
- 3 VTVM ME26 AU**
- 4 OSCILLOSCOPE OS-46/U**
- 5 SIGNAL GENERATOR SG-351/USD-1**
- 6 AUDIO FREQUENCY CODER KY-294/USD-1**
- 7 SURVEILLANCE DRONE TEST SET TS 1-1299/USD-1**
- 8 DC CIRCUIT BREAKER BOX**
- 9 BENCH LIGHT**
- 10 BLACK OUT SWITCH**
- 11 AC CIRCUIT BREAKER**
- 12 DC CONVERTER**
- 13 MAIN POWER SWITCH**
- 14 GYRO INSTRUMENT TESTING TILTING TABLE TS-1300/USD-1**
- 15 DC DISTRIBUTION PANEL**
- 16 SURVEILLANCE DRONE TEST SET TS-1297/USD-1**
- 17 SPECTRUM ANALYZER LA18M**
- 18 FIRE EXTINGUISHER**
- 19 VTVM ME 30B/U**
- 20 WORK BENCH**
- 21 OSCILLATOR TS 382 E/U**

Figure 45. Electronic shop truck.

and test console (see TM 11-5895-246-12). Maintenance for other equipment in the launch area is dictated by the TM's associated with the equipment. This maintenance consists of—

- (1) Preventive maintenance.
- (2) Troubleshooting.
- (3) Visual inspection.
- (4) Lubrication.
- (5) Servicing.
- (6) Replacement of major assemblies and components not requiring disassembly.
- (7) Performance check.
- (8) Adjustment.

c. Maintenance Area Equipment. First and second echelon maintenance is performed on maintenance area equipment (par. 11). (See TM 11-5895-246-12 and appropriate TM's associated with the particular equipment.)

This maintenance consists of—

- (1) Preventive maintenance.
- (2) Visual inspection.
- (3) Lubrication.
- (4) Electronic cable replacement.

Section III. PRELAUNCH AND LAUNCHING PROCEDURES

22. Final Drone Preparation

a. Transfer to Launcher. After drone preparation has been accomplished (par. 18) the drone is ready to transfer from the dolly to the launcher (except when drone is prepared on launcher). With the launcher in the horizontal position, mount the drone on the launcher in accordance with the procedure given in TM 11-5895-246-12.

b. Drone Fueling. Drone fueling (fig. 46) should be done only after the drone has been transferred to the launcher.

- (1) Move the fuel supply unit near the drone and rotate the agitator handle to mix the fuel and oil mixture thoroughly.
- (2) Connect the ground lead clamp on the fueling hose nozzle to the drone.
- (3) Remove the fuel tank filler cap.

Warning: Never remove the filler cap or attempt to refuel the drone until after a ground connection between the fuel servicing unit and the drone has been made.

- (4) Fill the drone fuel tank to about 2 centimeters from the

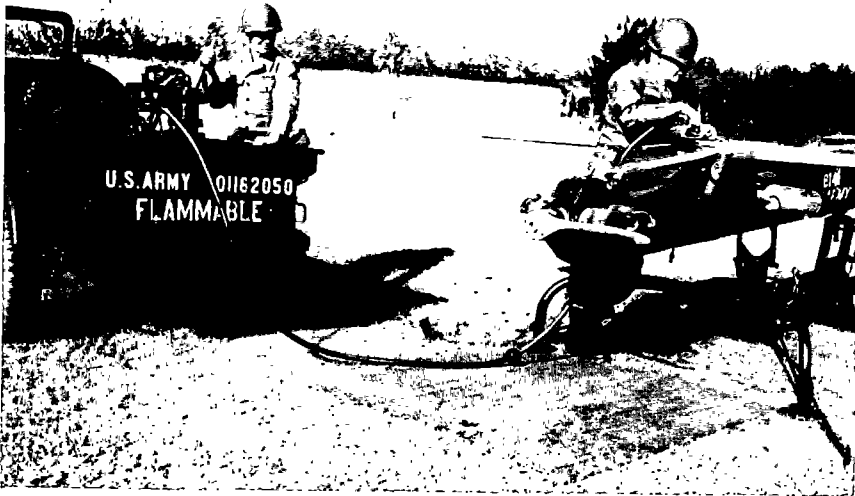


Figure 46. Drone fueling.

top (full capacity of the tank is 5.6 gallons). Be careful to prevent spilling fuel on the fuselage or ground.

- (5) Be sure that the O-ring packing is in place in the cap. Replace the filler cap securely.
- (6) Clean off all fuel that may be spilled over the fuselage. If any appreciable quantity has accumulated on the ground, completely cover the saturated portion of the ground with earth.

c. Battery Installation. Batteries are charged in the maintenance area and sent forward to the launch area as required. The battery is installed in the battery compartment and the battery cable connected. Separate batteries should be used for the checkout and the actual flight. The battery used for checkout should be replaced by a peak-charged battery after completion of preflight checkout and test. Checkout batteries are not required if test set TS-1297/USD-1 is used for preflight checkout and test. The peak-charged battery to be used for the flight must be checked under load prior to launch.

Caution: All power switches in the distribution box should be OFF before battery installation.

d. Preflight Checkouts and Test. The final preflight checkout will be accomplished in accordance with procedures prescribed by TM 11-5895-246-12. If this flight is to be a beacon-tracked mission the transponder beacon should be checked out with the radar if possible. The radar checkout is possible only when the

tracking radar has line-of-sight to the drone mounted on the launcher. Procedure for the transponder beacon checkout is as follows:

- (1) Place power switch on the auxiliary junction box in the DIRECT position.
- (2) Cover any two scimitar antenna elements with dummy loads from the AN/URM-125 beacon test set.
- (3) If the radar is unsuccessful in locking on any scimitar antenna, check the particular antenna for connection to the drone fuselage and all cable connections. If this check does not locate the trouble, the particular antenna element must be replaced.
- (4) After the radar has successfully checked out one antenna, change the dummy loads so that each antenna is exposed for radar lock-on.

Note. The AN/MPQ-29 radar should be able to lock-on regardless of which antenna is being tested and regardless of its attitude in relation to the radar.

- (5) If the radar is unsuccessful in locking-on, replace the AN/DPN-62V transponder beacon and send it back to the maintenance area for checkout with the AN/URM-125 transponder beacon test set.
- (6) The airframe and engine mechanics checklist and the control systems mechanics checklist should be completed upon completion of the beacon checkout.

e. Photoflash Cartridge Installation.

Caution: Before photoflash cartridge installation can be initiated, the battery used for checkout must be disconnected and removed as a safety precaution.

If the mission requires night photographic reconnaissance, the next step of final preparation will be photoflash cartridge installation (fig. 47). Installation should follow these steps:

- (1) Remove the photoflash cartridge covers from left and right ejectors.
- (2) Remove the photoflash cartridge-retaining brackets from the ejector assembly.
- (3) Remove the shunting primer clip (cap) from the M112 photoflash cartridge and install the cartridge in the mounting brackets.

Warning: Do not remove the shunting primer clip (cap) from the cartridge until just prior to loading the cartridge into the ejector.

- (4) Install the mounting brackets on the ejector assembly.

Note. The transponder beacon or camera access cover must be installed prior to installation of the mounting brackets on the assembly.

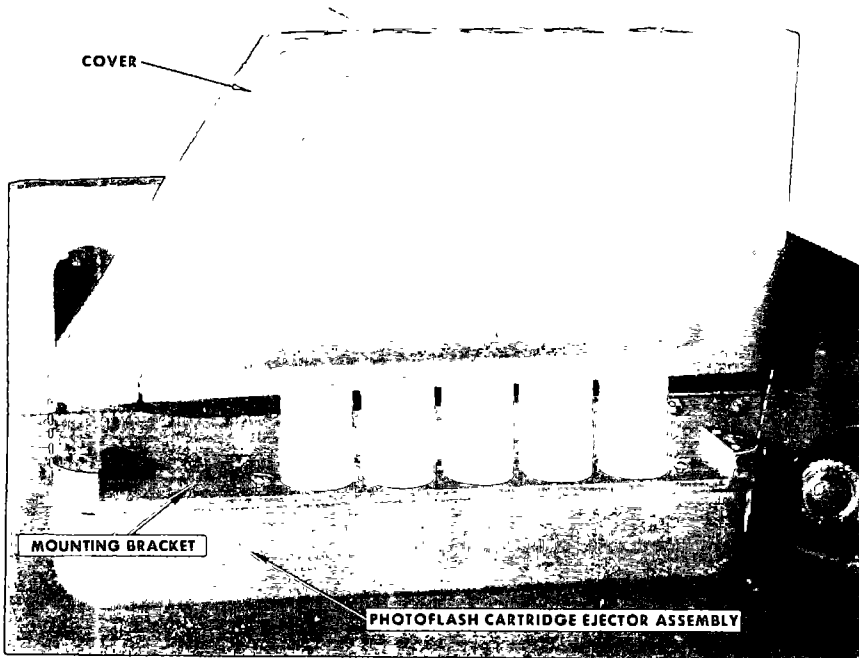


Figure 47. Photoflash cartridge installation.

- (5) Install the ejector covers making sure they are seated and in proper position.
- (6) Reinstall a fully charged battery (check voltage prior to installing) but do not connect the battery cable. It is possible to install the left rocket motor and still have opening of the battery access door large enough to allow battery cable connection. At time of launch connect the battery cable and apply normal launch procedures.

f. Rocket Motor Installation.

- (1) Prior to installing the rocket motors in the carriers, the following inspection will be performed:
 - (a) Inspect the packing and rocket motor for evidence of rough handling.
 - (b) Check for physical damage, such as dents in the body or nozzle or a broken igniter plug.
 - (c) Check for presence of snow, ice, frost, or other foreign matter.
 - (d) Examine for evidence of damaged or defective propellant as indicated by fragments of propellant, nitrous fumes, or musty odors.

- (e) Check nozzle to see that it is tightly assembled to the body.
- (f) Examine the expansion cone for the presence of the nozzle closure with its igniter plug and cables.
- (g) Check the nozzle closure for looseness; rocket motors with loose nozzle closures *will not* be fired.

Warning 1: Do not disconnect the shorting wire from the prongs of the igniter plug until ready to insert the plug in the firing socket.

Warning 2: Do not remove the nozzle closure to inspect the interior of the rocket motor.

- (2) Prepare rocket motor carriers for installation. (See procedure in TM 11-5895-246-12.)
- (3) Install the rocket motors in the carrier assemblies; be sure the bottles are properly sealed in the carriers.
- (4) Secure the rocket motors in the carriers with two bolts inserted through the lugs on the exterior of each carrier. Tighten the attaching nuts securely.
- (5) Install the rocket motor carriers with the rocket motors to the drone. *Do not remove the shorting wire from the igniter plug prongs.*
- (6) Check rocket motor alignment. (See procedures in TM 11-5895-246-12.)
- (7) Tape both rocket motor igniter wires near the plug to the drone fuselage. This prevents damage to the igniter circuit and plug during launching procedure. Leave the safety pins on the carriers in place until just before launch. (Figure 48 shows the left rocket motor installed and the safety pin in place.)

Note. Do not plug igniter plugs into the firing receptacle on the launcher until just prior to launch.

23. Prelaunch Mission Preparation

a. Radar Preparation.

- (1) The tracking and plotting team will coordinate with the controller in preparation for the drone surveillance mission. The drone section chief or the aerial surveillance platoon operations NCO will inform the controller and radar team of all details of the mission. The following information is required for adequate radar preparation:
 - (a) Location of radar.
 - (b) Target location.
 - (c) Target description.
 - (d) Target altitude.
 - (e) Time on target.

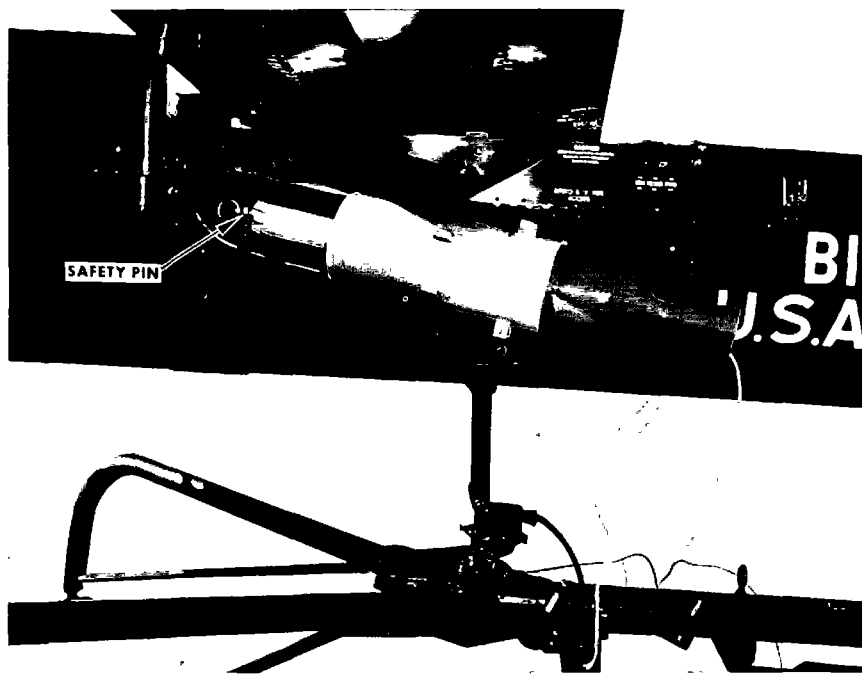


Figure 48. Left rocket motor installed.

- (f) FEBA penetration and re-entry points.
- (g) Airspace restrictions.
- (h) Recovery point or rendezvous point for transfer of control.
- (i) Miscellaneous instructions.

- (2) The controller will preplot his course on the radar plotting board from the launch area to the target and back to the recovery site (fig. 49). He will make notations of the altitudes, camera ON and OFF points, etc. along this course. A large scale map of the target should be on one board and smaller scale map on the other board (1:25,000 and 1:50,000). The entire mission route should be plotted on the smaller scale map. The target entry and departure routes and the sensor runs should be plotted on the larger scale map.

b. Flight Plan.

- (1) Once planning is complete, the drone section commander will notify the aerial surveillance platoon headquarters of the impending drone flight and will submit a flight plan including—
 - (a) Drone launch site.

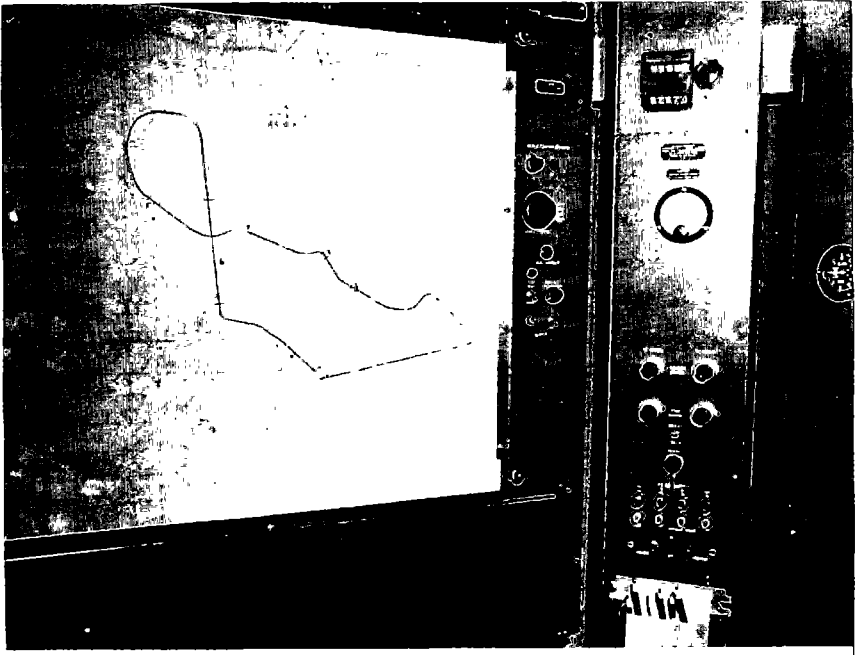


Figure 49. Radar mission outlined on plotting board.

- (b) Controller and radar sites.
 - (c) Launch time.
 - (d) Courses and altitudes.
 - (e) Method of tracking (skin or beacon).
 - (f) Recovery site.
- (2) If the drone section is attached to other units for operation, the drone section commander must file the drone flight plan with flight operation center (FOC), or flight coordination center, as appropriate. (The FOC will more likely be the agency which will provide the flight clearances for the drone section.)
- (3) A flight plan clearance must be received from FOC or flight coordination center, as appropriate, before launch.

c. Controller Coordination. The controller must coordinate with the launcher chief for all checkout procedures, and with the section chief for moving of ground-control station. The controller will set up the ground-control station at any site upon order from the section chief. During final launching procedures, communication and coordination between controller and launch site is most critical.

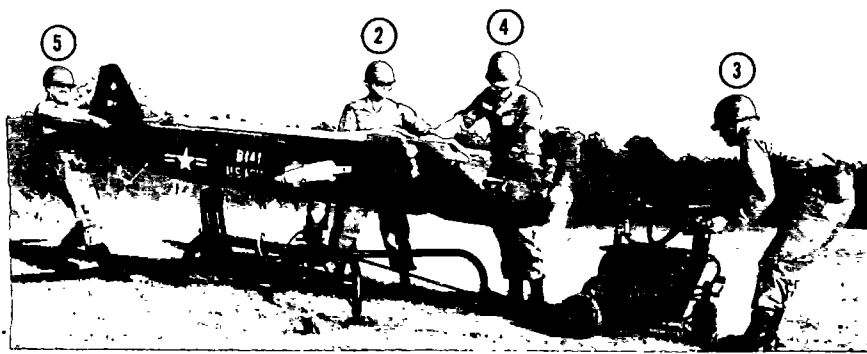


Figure 50. Launch team in position.

24. Launching Procedures

The launch team (fig. 50) is composed of the following:

Personnel	Rank	Drill No.
1 Controller	E7	①
1 Launcher chief	E6	②
2 Airframe and engine mechanics		
(Engine starter)	E4	③
(Engine tuner)	E4	④
1 Control system mechanic	E5	⑤

Warning: It is mandatory that every man involved with the launch countdown, exercise the utmost caution. All personnel not concerned with the launch must be in the safety zone.

a. Drone Engine Starting.

- (1) The controller ① will have the ground-control station warmed up and ready to transmit. He will normally be located at the drone control box in the launch area.
- (2) For night photographic reconnaissance, the launcher chief ② will connect the battery cable to the battery upon arrival at the launcher.
- (3) Launch team takes positions (fig. 50) for engine starting.
- (4) Airframe and engine mechanic ③ pushes the starter cart up to the drone and adjusts the starter dog height until it engages with the drone propeller hub. Then he disengages the dog and starts the hydraulic starter engine.
- (5) Airframe and engine mechanic ④—
 - (a) Turns the drone engine carburetor mixture control clockwise to the fully closed position, then backs off $\frac{3}{4}$ turn.
 - (b) Depresses the primer twice if the engine is cold.

Note. Do not prime a hot engine.

- (c) Avoids overpriming as this will cause flooding and the engine will not start.
- (d) Checks the ignition switch to make sure it is in the OFF position.
- (6) Airframe and engine mechanic ③—
 - (a) Engages the starter dog, exerting sufficient pressure to prevent the dog from disengaging, then quickly opens the starter hydraulic flow control valve.
 - (b) Turns the drone engine over several times to build up fuel pressure, then quickly closes the hydraulic flow control valve.
- (7) Airframe and engine mechanic ④ places the ignition switch in the ON position.
- (8) Airframe and engine mechanic ③—
 - (a) Opens the hydraulic flow control valve and cranks the engine.
 - (b) As soon as the drone engine fires, he disengages the starter dog and quickly closes the hydraulic flow control valve.

Note. Do not close the hydraulic flow control valve when the engine starts, but do close it as the starter dog is disengaged.

- (9) Airframe and engine mechanic ④—
 - (a) Opens the mixture control when the drone engine starts and adjusts the fuel mixture by turning the mixture control clockwise until the drone engine begins to slow down.
 - (b) Turns the mixture control counterclockwise until the engine starts to fire on every second cycle (four-cycling).
 - (c) Turns the mixture control clockwise, slightly, until the engine stops four-cycling, except for an occasional misfire. This will be the proper carburetor setting.

Note. If the engine fails to start after approximately 100 revolutions, turn the IGN switch to OFF and close the carburetor mixture control completely. Pull the propeller in reverse rotation (clockwise) several times to clear the excess fuel. Turn the IGN switch to ON again, engage the starter dog, and repeat the starting procedure beginning with (8) above.

Caution: Operate the drone engine for short periods only, prior to actual flight and while on the ground to prevent overheating. If the launch is delayed to make adjustments or corrections to launch equipment, stop the engine until such changes are made and the drone is ready to launch.

- (10) Airframe and engine mechanic ③—
 - (a) Immediately after the drone engine starts he pulls the

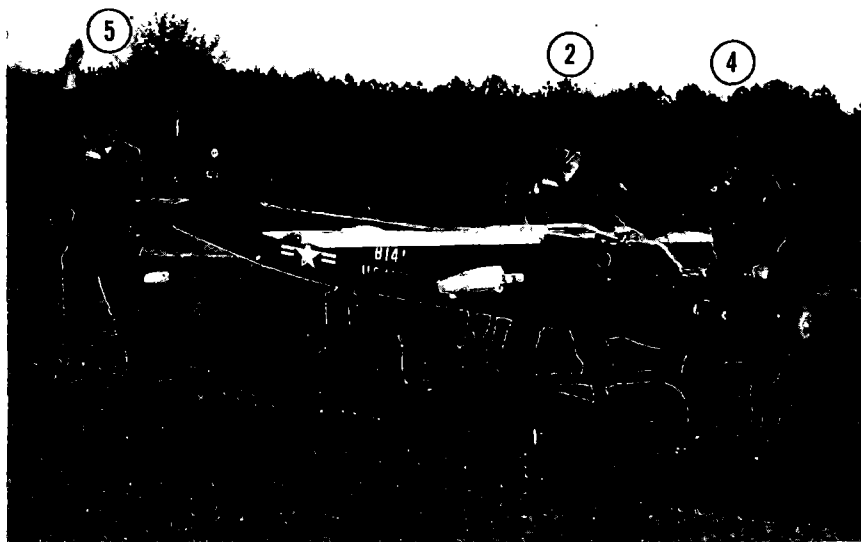


Figure 51. Control system mechanic making control checkout.

hydraulic engine starter to a position approximately 6 meters to the right of the launcher.

- (b) Moves to a position opposite the launcher chief (2), behind the right wing of the drone.

(11) Airframe and engine mechanic (4)—

- (a) Checks the engine rpm by placing the vibrating reed tachometer on the outboard leading edge of the wing. The tachometer is used to peak the engine to maximum rpm.
- (b) After the engine is peaked, he moves to a position to the left rear of the launcher and holds the launcher power cable up for the launcher chief (2) to see.

b. *Control Checkout.*

- (1) The control system mechanic (5) acts as anchor man during engine starting (fig. 50).
- (2) As the airframe and engine mechanic (3) removes the hydraulic starter, the control system mechanic (5) makes the control system checkout (fig. 51).
- (3) The control system mechanic (5) requests a 50° left and a 50° right command from the controller and observes that the ailerons respond properly. (All command requests are done by hand and arm signals.)
- (4) The control system mechanic (5) requests a 30° up and



Figure 52. Launcher chief removing left rocket motor safety pin.

30° down command and observes that the elevator responds properly.

- (5) The control system mechanic ⑤ requests a 0° roll and a 0° pitch command from the controller and observes that the control surfaces return to streamline. If the control surfaces do not streamline, the controller ① must adjust the ailerons and elevators with the ROLL and PITCH trim knobs on the master flight control box.
- (6) If this is a night mission, the control system mechanic requests a night light command and observes that all three navigation lights are burning.
- (7) Upon completion of the control system checkout, the control system mechanic ⑤ moves to the launch area trailer and observes the TS-1297/USD-1 test console and the frequency monitor.

c. Removal of Safety Pins and Straps.

- (1) The airframe and engine mechanic ③ pulls the right rocket motor safety pin and hands it to the launcher chief ②, then the airframe and engine mechanic ③ removes the shorting wire from the rocket motor plug



Figure 53. Launcher chief placing launcher in launch angle.

and inserts the plug in the rocket motor firing junction box on the launcher.

- (2) The airframe and engine mechanic ③ moves around the tail of the drone to a position approximately 5 meters from the left side of the drone. He stands by to assist the launcher chief ② if necessary.
- (3) The launcher chief ② removes the left rocket motor safety pin (fig. 52); he removes the rocket motor shorting wire from the plug and connects the plug to the rocket motor junction box on the launcher.
- (4) The launcher chief ② releases the launch angle latch and pushes down on the drone tail (fig. 53) until the rear support latches in the selected launch angle, at which angle the pip pin has previously been placed.
- (5) The launcher chief ② pulls the safety pin from the drogue gun and closes the access door.

Warning: Make sure that the parachute door is latched before removing the parachute door strap; if the door is not latched, it will open and fire the drogue gun.

- (6) The launcher chief ② removes the parachute door strap.
- (7) The launcher chief ② checks the streamline position of the controls and the general condition of the drone. Then

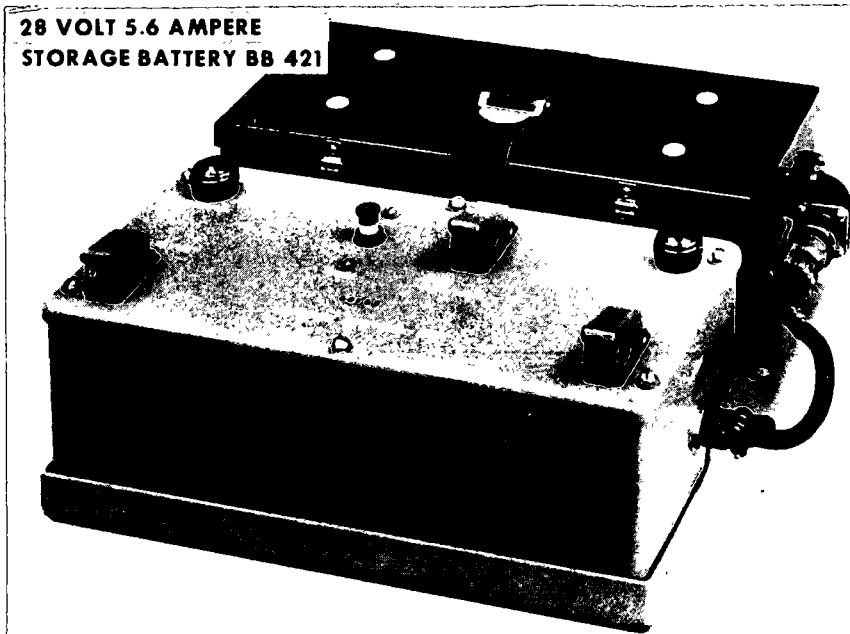


Figure 54. Launch control box.

he moves to the end of the rocket motor arming lanyard (approximately 3 meters from the left side of the launcher) and arms the rocket motor firing circuit.

- (8) The launcher chief ② and the airframe and engine mechanic ③ move to the launch control box.
- (9) The launcher chief ② hands the parachute door strap and three safety pins to the airframe and engine mechanic ④.

Caution: It is mandatory that the airframe and engine mechanic count the door strap and three safety pins. There must be one parachute door strap, two rocket motor safety pins and one drogue gun safety pin.

d. Launching. The launcher chief—

- (1) Connects the launcher power cable (CX-4808/U) to the receptacle on the launch control box (fig. 54).
- (2) Checks with the controller for clearance to launch.

Note. Under no conditions will the drone be launched without clearance from the flight coordination center or the drone section commander.

- (3) When clearance to launch has been granted, he sets the

ARM SWITCH to ON. The ARM indicator on the launch control box should light.

- (4) Indicates to the controller with his right hand that the drone is prepared to launch. The controller then indicates he is ready for flight operations.
- (5) Indicates by right-arm movement a countdown of three. At mark three he presses both the right and left PUSH TO FIRE switches simultaneously.
- (6) After a successful launching, he disconnects the launch control cable at the launch control box.

Warning: In the event of a misfire, the launcher chief must set the launch control box ARM SWITCH to OFF and disconnect the launch control cable from the launch control box. Observing maximum caution, determine the cause of misfire and take the necessary corrective action (ch. 9).

- (7) If the drone should require corrective action, the launcher chief will install the safety strap on the parachute door and the safety pin in the drogue gun firing mechanism. He disconnects the rocket motor firing wires from the firing junction box on the launcher and installs the grounding wire. He places the power and ignition switches of the drone main junction box in the OFF position.
- (8) The launch team performs the necessary corrective action and repeats the launching procedure.

CHAPTER 5

FLIGHT OPERATIONS

25. In-Sight Flying

In-sight flying (fig. 55) is the flight operation of the drone aircraft at ranges and altitudes within the visual limits of the drone controller.



Figure 55. In-sight flying.

a. Rocket Assist Takeoff Phase and Climbout.

- (1) The flight operations immediately following the launching of the drone constitutes the rocket assist takeoff phase. During this phase, the drone must be flown with no commands from the flight control box. The rocket motors will automatically jettison after burnout, and the drone will continue flying. The drone reaches its normal airspeed shortly after rocket motor jettison; at that time the controller may command changes in flight attitude. The entire rocket assist takeoff phase is completed in about 4 seconds; therefore, the controller must be alert because immediate flight attitude changes may be necessary, especially if the rocket motors fail to burn evenly.
- (2) After normal flying speed has been reached, the climb angle can be increased or decreased as necessary. At higher than normal airspeeds, the effect of the elevator increases and an extreme pitch command can easily result in excessive pitch attitude of the drone. The controller obtains the desired flight attitude by adjusting the PITCH control knob on the flight control box.
- (3) To accomplish a turn in either direction, the controller rotates the ROLL control knob on the flight control box to align the pointer mark with the desired roll or bank angle marking. The drone will turn as it banks, to the selected angle.

Caution: Turns should not be attempted until the drone has climbed to a safe altitude and attained sufficient speed to provide full control.

- (4) When executing turns, rotate the ROLL knob to left or right as desired. At the same time, rotate the PITCH knob from 2° to 4° *up* from level flight to compensate for the loss of lift caused by the steep bank angle.

b. Level Flight and Trim Control. After climb-out to a safe altitude (800 feet or higher) the trim characteristics must be checked. The drone should be trimmed up for level flight in accordance with the following procedure:

- (1) Place the flight control box ROLL and PITCH knobs at 0° position.
- (2) Rotate the ROLL TRIM knob a small amount at a time until the drone is flying a straight course.
- (3) Rotate the PITCH TRIM knob a small amount at a time until the drone is flying a level course.

c. Stalls and Acrobatics. Stalling speed of the drone at sea level is approximately 70 knots. Flight maneuvers limited to 55° roll and 35° pitch. Acrobatics cannot be accomplished with this con-

trol system, and stall is difficult to achieve. For drone performance data, see TM 11-5895-246-12.

Caution: Any rapid movement of either the **ROLL** or **PITCH** control knobs on the control box from one extreme command to the opposite may cause the gyro to tumble, thus losing control of the drone.

d. Control Transfer and Radar Lock-On.

- (1) If the tracking radar is located near the launch area, the drone is normally launched and flown in-sight by the controller until radar lock-on. Once the radar has locked on, the controller transfers control to the remote control box inside the radar van and moves to his position there.
- (2) When the radar is located some distance from the launch site, the controller must transfer control to the ground-control station at the tracking radar. Control should be transferred only when at least one controller has the drone in sight at all times. The procedure for transferring control is as follows:
 - (a) There must be direct communication (radio or wire) between the controller releasing control and the controller gaining control.
 - (b) The releasing controller flies the drone to a predetermined point so that both controllers have the drone in sight.
 - (c) When the gaining controller has the drone in sight, he notifies the releasing controller that he has the drone in sight and is ready for the transfer.
 - (d) When the releasing controller is notified, he gives the gaining controller a **STANDBY FOR COUNTDOWN** command.
 - (e) The releasing controller starts the countdown: one, two, three (on the command **THREE**, the releasing controller switches his carrier command **OFF**), four (on the command **FOUR**, the gaining controller switches his carrier command **ON**), five.
 - (f) Immediately after the gaining controller takes control, he gives the drone a 20° left or right **ROLL** command. If the drone responds accordingly, transfer is complete. Should the drone not respond to the command, the gaining controller gives the releasing controller a command **NEGATIVE CONTROL** and simultaneously switches his carrier command **OFF**.
 - (g) When the releasing controller receives the command **NEGATIVE CONTROL**, he immediately switches the carrier command **ON**. He then gives the drone a

command to make sure that he has control of the drone. If the drone is out of his sight, he requests guidance information from the gaining controller to bring the drone back to his area.

Caution: Transfer must be rapid and systematic because the drone will automatically set the recovery system in operation if carrier command is lost for more than 6 to 14 seconds.

- (h) If the control transfer is successful, the gaining controller will fly the drone in sight until radar lock-on.

e. *Emergency Operation.* Emergency operations will normally be due to loss of control or engine failure.

- (1) Loss of control may result on launch when the rocket motors fail to burn properly and cause the gyro to tumble. At any time the controller determines the drone is not responding to the commands he immediately depresses the INSTANT CHUTE command button on the control box. The only exception to this is when the drone has a chance of falling into enemy territory; then he should attempt to dive the drone into the ground. Loss of control may also result because of the following: gyro tumble, control surfaces being damaged, control system malfunctions, and ground-control station failure. If the ground-control station fails, control should be transferred immediately to the standby control station.
- (2) If the drone engine fails during flight, a glide should be established to glide the drone toward an area where it can be recovered. If the altitude is not sufficient to establish a glide, initiate the INSTANT CHUTE command. If possible, the drone should be glided into the wind. All turns should be shallower in ROLL command and such steeper in DOWN PITCH command than a normal descending turn. For emergency flight operation, see figure 56. For emergency recovery procedures, see chapter 6.
- (3) During a combat situation, the controller may detect that the drone is following erratic flight commands. Usually this will be due to difficulties within the drone control system or the employment of electronic countermeasures against the drone. Repetition of erratic control or loss of control will indicate use of electronic countermeasures. If control is being lost, the controller should attempt to destroy the drone by diving it into the ground or tumbling the gyro. The only effective electronic countermeasure (ECCM) is to change the control fre-

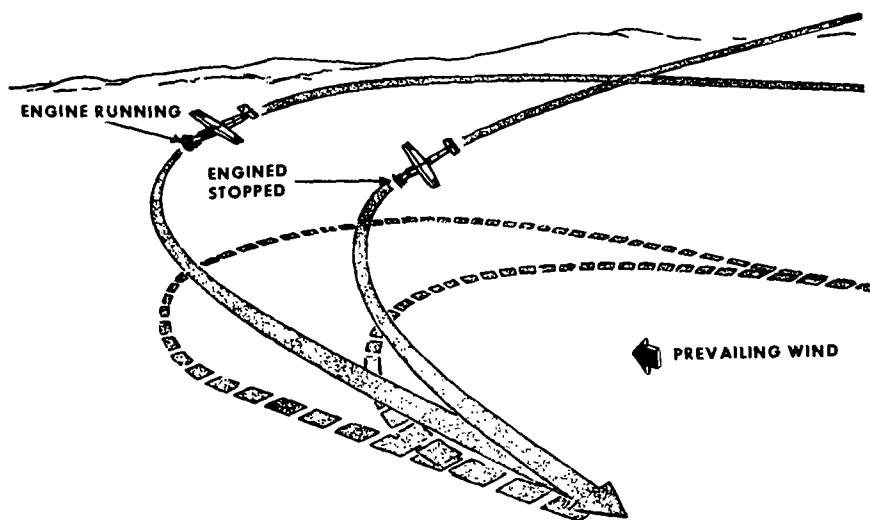


Figure 56. Emergency flight operation.

quencies for the next mission. In order for the enemy to acquire control of the drone while in flight, he must be able to get on a frequency with a 50-50 duty cycle. This would be difficult but not impossible. For more details on electronic warfare, see FM 24-150.

26. Out-of-Sight Flying

Out-of-sight flying is the flight operation of the drone aircraft at ranges and altitudes beyond the scope of normal vision. The drone must use some type of automatic guidance and control or a radar tracking unit such as the AN/MPQ-29. The drone is tracked and plotted by radar tracking set AN/MPQ-29 (fig. 57), presently the only tracking device for the AN/USD-1 Drone organic to the aerial surveillance platoon. Successful out-of-sight operation of the drone requires the controller to hold the drone on a precise heading and to make precise turns while observing a radar plotting board.

a. Radar Capabilities and Limitations.

- (1) The AN/MPQ-29 tracking and plotting radar is used to track and plot the course of either drone or manned aircraft. The course being plotted is presented visually by a light under a standard scale tactical map. Directly behind this light is a pen which plots the course of the drone (or aircraft) on vellum overlay paper. The course is oriented with the map and is used to pinpoint locations from which aerial intelligence may be determined. For

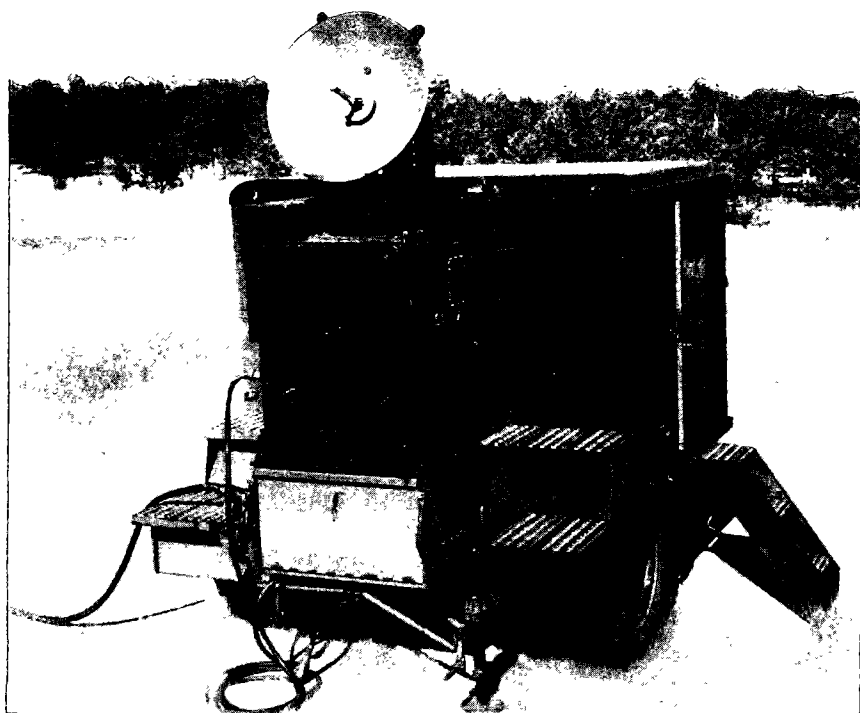


Figure 57. AN/MPQ-29 tracking and plotting radar.

the highest degree of accuracy, the radar should be positioned by fifth order (1:1000 artillery survey) and the orienting line established to an accuracy of ± 1 mil.

- (2) The radar will transmit and receive frequencies between 8,500 and 9,600 megacycles. It is tunable throughout this frequency band from the radar control panel. The receiver is automatically tuned when the transmitter is tuned. The gain of the receiver can be controlled either manually or automatically to maintain a constant signal strength at any range.
- (3) The radar has three methods of target selection:
 - (a) *The target selector method* uses an optical sighting instrument which automatically slaves the radar antenna to the same azimuth and elevation as it is sighted. The optical sight consists of binoculars (7 power, 50 mm field) mounted in a clamp on the instrument. Target selection is limited by visual observation through the binoculars.
 - (b) *The search mode* searches 360° at a scanner rotation

of 60 revolutions per minute. At the same time it scans either 200, 400, or 600 mils in elevation. Once a target is spotted on search mode, the operator usually goes to sector scan to identify the target.

- (c) *The sector scan mode* is another method of target selection. In the sector scan mode the antenna will scan an area 300 mils in azimuth and either 200, 400, or 600 mils in elevation. In this mode of operation the antenna may also be controlled manually, thus making possible a scan of any desired sector. This can be especially helpful when a mission is planned and the aircraft is expected at the rendezvous point.
- (4) The radar has two identical plotting boards which will operate independently or together (optional). They may be designated as the coarse and fine board, or as the A and B board. The boards are capable of using four different scales of standard military maps: 1:25,000, 1: 50,000, 1:100,000, and 1: 250,000. For example, one board could be used with a 1:100,000 map to plot the gross part of the mission while a 1: 25,000 map is being used to plot the target portion of the mission. The radar plots the 1: 25,000 (larger scale) with greater accuracy.
- (5) The drone controller uses the plotting board to guide the drone to the target and return. He watches the tracking light as it moves across the board and corrects the drone as necessary. He must also observe the altitude indicator to correct for elevation. Each plotting board is equipped with a climb-dive meter to indicate to the controller the rate of change in altitude up to 1,500 feet per minute in either a climb or a dive.
- (6) Each new radar site will have different limitations as to the range and altitude a target can be tracked.

b. *Skin Tracking Mode.* In the skin tracking mode of radar tracking, the radar transmits a radar pulse and receives a return pulse from the skin of the target. Skin tracking requires the transmitter and receiver to be tuned up on the same frequency.

- (1) To skin track the AN/USD-1 drone, the drone must be launched and orbited in sight until radar lockon.
- (2) Using the AN/MPQ-29 radar, the maximum reliable skin tracking range is approximately 10 kilometers without the drone's radar reflector pods. The maximum reliable range using the drone's radar reflector pods is approximately 14 kilometers. The reliable tracking range will vary according to site location, atmospheric con-



Figure 58. Cumulonimbus cloud.

ditions, etc. Radar reflector pods should only be used as as a secondary or alternate method of increasing the tracking range.

- (3) Skin tracking should not be attempted when there are numerous high moisture content clouds present in the flight area (e.g., cumulonimbus clouds, fig. 58, and nimbostratus clouds, fig. 59). These clouds nullify the reflected response to the tracking radar.

c. Beacon Tracking Mode. In the beacon tracking mode of radar operation, the radar transmits a radar pulse which interrogates a transponder beacon in the target. When the beacon has been interrogated it will trigger its transmitter which transmits a radar pulse back to the radar on a different frequency. This mode of radar operation requires the tracking radar to transmit and receive on the frequencies preset in the AN/DPN-62V transponder beacon.

- (1) The AN/DPN-62V transponder beacon is used with the AN/USD-1 drone. For details about the AN/DPN-62V transponder beacon, see paragraph 10b(2).
- (2) The radar may lock on the transponder beacon before



Figure 59. *Nimbostratus* cloud.

the drone is launched, provided there is line-of-sight between the launcher and radar or lock-on can be accomplished after launch.

- (3) Reliable beacon tracking range for the drone will vary according to transponder strength, radar power output, atmospheric conditions, radar site location, etc. Maximum range capability should be possible with the transponder beacon if optimum conditions exist.
- (4) The drone can normally be beacon tracked into overcast conditions without difficulty. It can also be tracked below the mountain ridge line (i.e., in valleys) provided line-of-sight can be maintained between the drone and the tracking radar.

d. Mission Control Techniques. The methods of controlling and tracking each mission will vary greatly according to the mission requirements.

- (1) Missions demanding launch under zero (visibility) and zero (ceiling) conditions will require the controller to use the radar tracking indication to trim the drone for straight and level flight. The following procedure should be followed:

- (a) Place the flight control box ROLL knob at 0° position.
- (b) Fly the drone in a straight line.
- (c) Take a radar plot of at least 5,000 meters.
- (d) Rotate the ROLL TRIM knob a small amount at a time to correct any flight path curvature until the drone is flying a straight course.

Note. Normal compensation will be the equivalent of from 6° to 8° right ROLL TRIM.

- (e) Again fly the drone in a straight line.
- (f) Take a radar plot of at least 5,000 meters.
- (g) Slowly rotate the PITCH TRIM knob until the drone flies a level course.

Note. PITCH TRIM will very often be the equivalent of from 6° to 10° down.

- (h) Apply trim measurements determined as zero reference points in flight attitude.

Caution: If the drone cannot be trimmed within the limits of either TRIM control, system malfunction or maladjustment is indicated. Return the drone to the recovery area and initiate the recovery phase.

- (2) When the radar is using the skin tracking mode, tracking can be transferred from one radar to the other. This transfer can only be made when both radars are using different frequencies.
 - (a) If the initial tracking radar is using skin tracking mode, then a second radar could pick up the drone using the beacon tracking mode on different transmitting and receiving frequencies.
 - (b) If the initial tracking radar is using beacon track mode, the second radar cannot pick up the drone on beacon track. In this case, one radar would interfere with the other by triggering the beacon out of sequence with the tracking radar. This would result in a lost target with neither radar able to lock-on.
 - (c) The initial tracking radar may use the beacon tracking mode if the second radar picks up the target using the skin track mode.
- (3) When using one radar, the beacon tracking mode is preferred since it gives the maximum range capability.

27. Night Flying

Night flying operations are similar to daylight flight operations.

a. Controller techniques at night will be different from daytime operations because the only indication of the drone's attitude at night is the three standard navigation lights. The night lights

should be on during night launching and visual flying. (Night tactical missions must be flown without lights and the launch will be the same as under zero zero conditions. See paragraph 26d.) Normally the lights should be flashing; however, if the flasher becomes inoperative it can be bypassed and the lights will remain on. The flashing night lights enable the controller to see the drone at greater ranges. Since the red light is visible at greater ranges than the green light, extreme caution must be taken to distinguish these lights at distant nighttime ranges. It is difficult to tell the direction of turn without observing both lights. Normally the drone can be visually controlled at greater distances at night than daytime, depending on weather conditions.

b. Out-of-Sight Flying. If the mission is to be flown on radar, the tracking radar locks on; the controller then takes his position inside the van and checks the plotting light for the drone's position on the plotting board. Normally he should turn off the night lights on the drone; however, during training flights the lights should remain on. Use of the KS-53A camera system is discussed in chapter 8.

CHAPTER 6

RECOVERY OPERATIONS

28. Recovery Area Site Selection

The recovery area site should be well removed from the disposition of friendly troops. It should be centrally located to the other elements of the drone section and relatively near the photographic processing unit. Sufficient recovery areas are selected so that the same area is not used in successive recoveries. Desirable general characteristics include—

- a. Accessible road nets.
- b. Line-of-sight between controller and recovery area.
- c. Reasonably flat and obstacle-free terrain.
- d. Accessibility to launch and maintenance areas.
- e. Freedom from enemy ground observation.
- f. Avoidance of interference with other elements or installations.

29. Recovery Area Operation

Recovery areas are normally operated by a recovery team formed from the maintenance team, upon order of the maintenance team chief. The recovery team may be formed from the launch team if the recovery site is to be located in a forward area. When a photographic processing unit is not readily available at the recovery area, the camera may be transported by organic vehicle or by a helicopter provided by the GS aviation company.

30. Normal Recovery

a. *Visual Recovery.* The visual method is the most reliable method of recovery. A ground-control station should normally be located at or near the recovery site.

- (1) The recovery site controller gains control from the radar controller after he has the drone in sight. After control is transferred to the recovery site controller, the drone is descended to the desired recovery altitude (500 to 800 feet).
- (2) The drone is flown upwind to the recovery area. While holding at least 500 feet altitude, the controller gives a 5° UP pitch command, prior to parachute release, to dissipate the airspeed. When the drone is over the position required for parachute release (allow for parachute wind drift), the controller depresses and holds the CHUTE INSTANT button on the flight control box until the engine stops and the parachute is deployed.

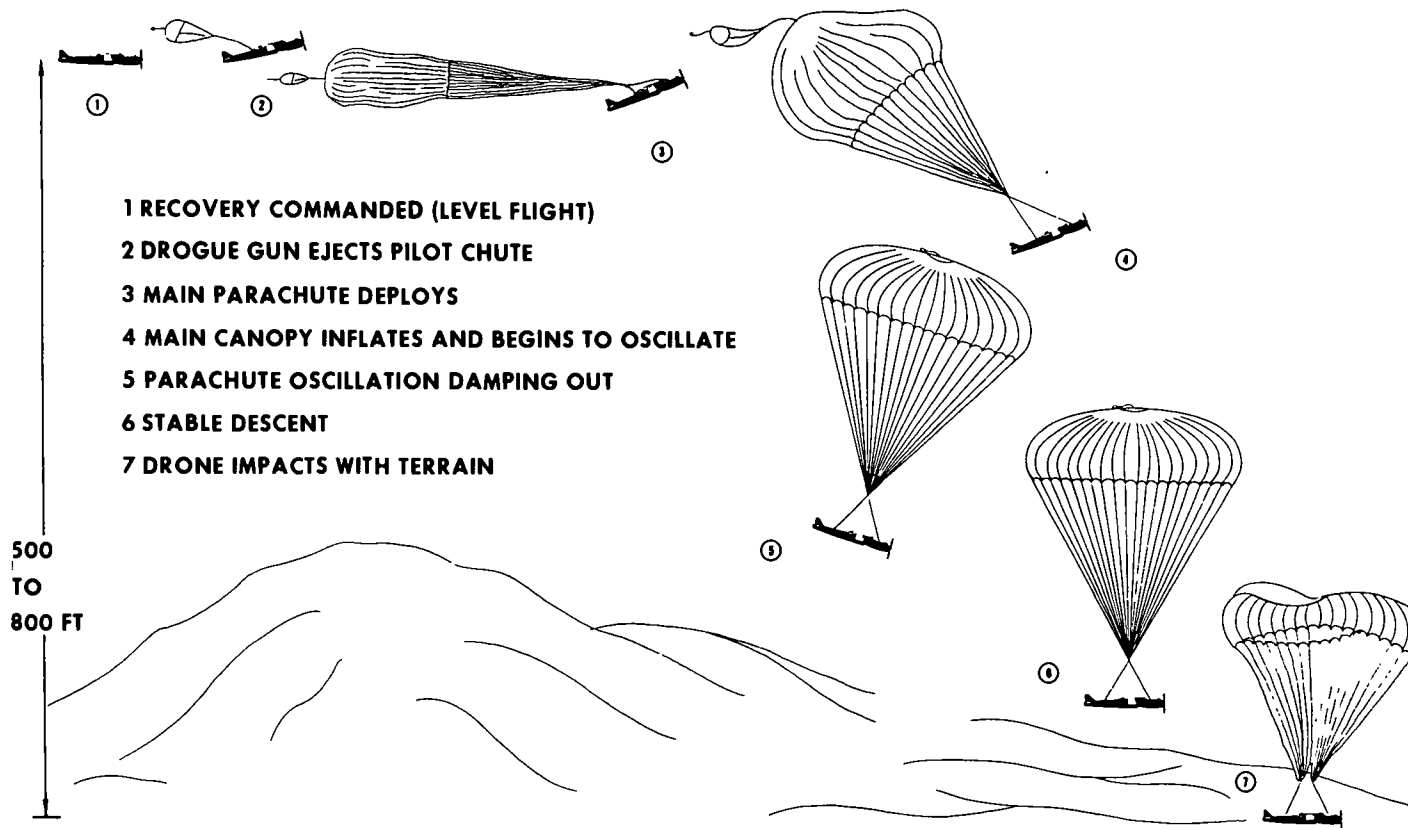


Figure 60. Normal recovery.

If the CHUTE INSTANT switch fails to activate the recovery system, the emergency procedure described in paragraph 31 should be followed.

- (3) Figure 60 illustrates normal drone recovery sequence after the recovery command has been initiated.
 - (a) *Step 1.* With the drone in level flight, a recovery command is initiated. The—
 - 1. Parachute door opens.
 - 2. Ignition cutoff switch actuates.
 - 3. Drogue gun fires.
 - 4. Engine stops, and after 10 seconds the parachute time-delay relay is energized.
 - (b) *Step 2.* The drogue gun ejects the pilot chute from the parachute compartment. The—
 - 1. Pilot chute inflates.
 - 2. Force of the pilot chute ejecting breaks the main parachute harness retaining cord and initiates the main parachute deployment.
 - (c) *Step 3.* The main parachute deploys, breaking the butterfly skirt hesitator. The—
 - 1. Drone pitches upward.
 - 2. Impact switch actuates but is prevented from disconnecting the parachute because the time-delay relay has not completed the circuit.
 - (d) *Step 4.* The main canopy inflates and begins to oscillate.
 - (e) *Step 5.* The parachute oscillations damp out rapidly.
 - (f) *Step 6.* The drone is in stable descent and time-delay relay has completed the circuit in the parachute disconnect system.
 - (g) *Step 7.* The drone contacts the ground. The—
 - 1. Impact switch actuates, completing the electrical circuit to the squib assemblies.
 - 2. Squibs fire and the parachute disconnects from the riser harness.
 - 3. Parachute drifts to the ground.

b. Out-of-Sight Recovery. Drone recoveries can be made by the controller while flying the drone on radar. Recoveries can also be made by a remote controller when he does not have visual contact with the drone.

- (1) *Radar recovery with final recovery talk-down.*
 - (a) The recovery team chief notifies the controller by radio or wire, if available, that he has the drone in sight.
 - (b) The recovery team chief then tells the controller the commands to give the drone. On command from the

recovery team chief, the controller descends the drone to a minimum altitude of approximately 800 feet, then proceeds to line-up the drone in a recovery flight path.

- (c) When the drone arrives over the desired parachute release point, the recovery team chief commands INSTANT CHUTE to the controller.

Note. The recovery team chief should be checked out as a controller or should have drone controlling experience.

- (d) If the recovery system fails to effect recovery, the drone is climbed to altitude so the radar may again lock-on the drone (if lock-on was lost). Then the drone must be flown to an alternate recovery area where a ground control station is available to carry out emergency procedures.
- (2) *Radar recovery with no talk-down.* This type recovery can be used whenever other recovery means are not available. For this method, the radar controllers plots the recovery area and flies drone over the area at the lowest possible radar tracking altitude (not less than 1,000 feet above the ground). When the drone is flown over the area the INSTANT CHUTE command button is depressed. This method of radar recovery should not be used except when communications are not available by any means and a radar recovery is the only method possible for recovery.
 - (3) *Out-of-sight recovery with the controller in a remote location.* This type recovery can be made when only one ground-control station is operative. For this method, the controller visually flies the drone in the general direction of the recovery area until the recovery team sights the drone and recovery team chief tells the controller the commands necessary to effect recovery ((1) above).

31. Emergency Recovery

Emergency recovery is necessary when depressing the CHUTE INSTANT command does not result in a normal recovery. Some of the more common emergency recovery procedures are—

a. Failure of Recovery System and Drone Engine Continues to Operate. The cause will usually be failure of the parachute door release mechanism to operate, parachute door jammed, or failure in the command control system.

- (1) Maintain level flight and climb the drone to a minimum of 1,000 feet. Fly the drone around in a pattern for another recovery run.
- (2) On the second pass over the recovery area, depress the

CHUTE DELAY button and hold for at least 20 seconds; simultaneously roll the drone right and left. If this fails to operate the recovery system, repeat step one.

Caution: When depressing the CHUTE DELAY button, the controller will have no pitch command control.

- (3) On the third pass over the recovery area, shut down the station by placing the CARRIER switch on the control box in the OFF position. If the recovery system still fails to operate and the engine stops, place the CARRIER switch in the ON position and dive the drone to air-start the engine and regain control of the drone. If the engine continues to operate, the pea lead (magneto grounding wire) is not connected. Repeat step one in preparation for a controlled emergency landing.
 - (a) Keep the drone in flight until the fuel is almost exhausted; meanwhile, select a landing place that is not covered with rocks or trees. Fly the drone into the wind and toward the selected landing place and gradually decrease altitude.
 - (b) Approximately 200 to 300 meters from the desired touchdown point, and at an altitude of 50 feet, depress the CHUTE INSTANT button. This will stop the drone's engine and rapidly slow the drone to reduce the impact.
 - (c) The roll control must be used to keep the wings level. The CHUTE INSTANT button can be released when the engine stops and after the speed is decreased.

Note. If the pea lead is not connected, the engine will not stop. See TM 11-1550-200-12.
 - (d) Just before touchdown, and when the selected landing area is reached, rotate the PITCH control knob UP as necessary to drop the tail, so that the drone will land on its aft keel (fig. 61).

Warning: When the drone is landed with the parachute still in the drone, it is mandatory that the parachute door be secured by the door strap, and that the drogue gun safety pin lanyard be installed immediately. Keep clear of the drogue gun opening in the parachute door. Approach the drone from the right rear side, reaching over the drone to first fasten the door strap and then to install the drogue safety pin lanyard.

- (e) On the drone main junction box, place the IGNITION and POWER switches to OFF. If the drone is not to

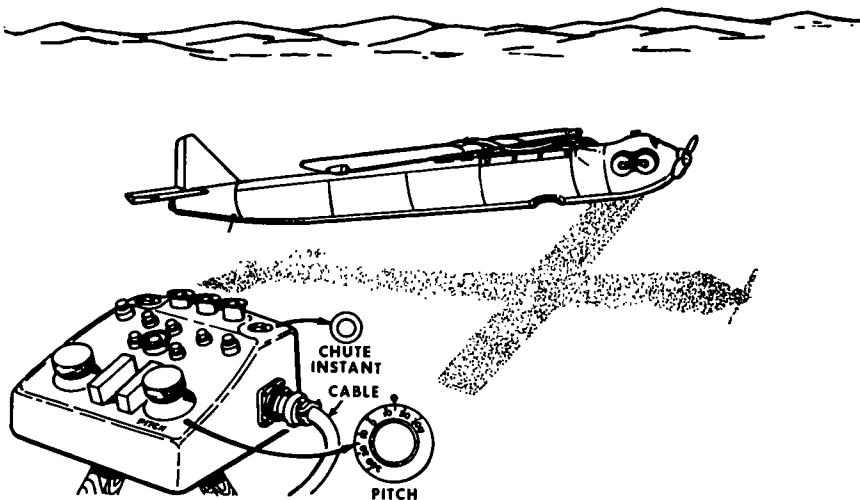


Figure 61. Emergency recovery.

be used for another flight, the drogue gun must be removed from the drone as follows:

1. Open the equipment access door and unscrew the firing mechanism from the drogue gun body. Remove the cartridge and store it in the ordnance storage area. Point the firing mechanism at the ground and pull the safety lanyard to release the tension on the spring.
2. Reassemble the drogue gun and store it in the launch trailer.

b. Failure of Recovery System and Drone Engine Stops. The usual cause will be failure of the parachute door release mechanism or jamming of the parachute door. The drone engine should air-start approximately 6 to 14 seconds after release of the CHUTE button. If an air-start is impossible, execute a forced landing. Place the drone in a glide and guide it toward a clear area. Make a touchdown as described in *a(3) (d)* above.

c. Failure of Parachute to Deploy When Parachute Door Opens. When this occurs, the drogue gun has failed to fire or the drogue gun lanyard was not connected to the pilot parachute. Usually the engine will stop and cannot be air-started. Make a forced landing (*b* above).

d. Failure of Parachute to Deploy Because Squib Quick-Release Device Fired in Air, Thus Disconnecting Parachute From Drone. This failure is caused by a grounded squib firing circuit. The drone

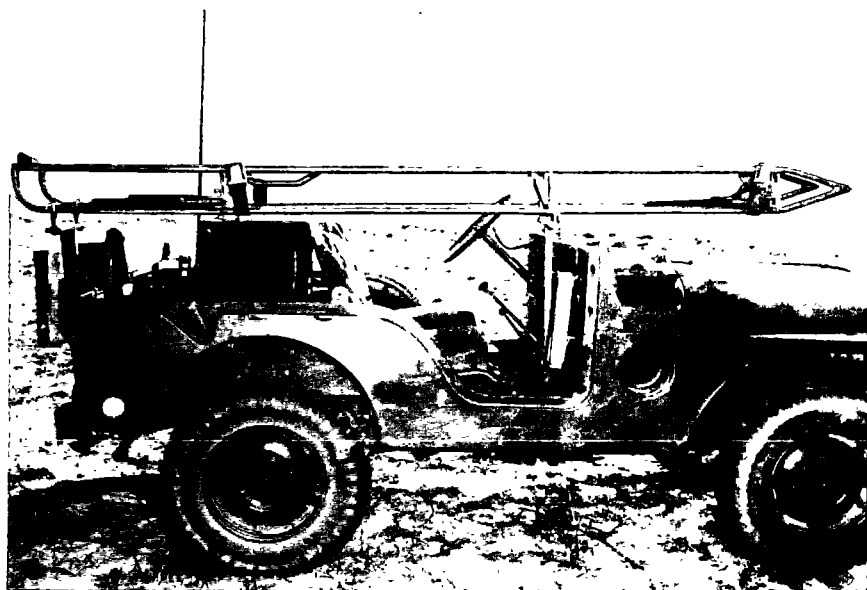


Figure 62. Truck, 1/4-ton, ready for recovery.

engine cannot be air-started and a forced landing is necessary (*b* above).

e. Other Emergency Recoveries.

- (1) The drone's fuel supply may become exhausted. This should not happen unless the drone is flown longer than 30 minutes. If fuel starvation is apparent (by rapid decrease in speed, or by the sound of the engine indicating slowdown or imminent stoppage of engine) initiate a normal recovery. If the parachute fails to deploy, attempt a forced landing (*b* above). If over enemy territory, dive the drone into the ground in an attempt to destroy it.
- (2) If the drone's engine fails during flight, attempt a normal recovery. If over enemy territory, dive the drone into the ground.

32. Retrieving on Land

Drone retrieval operations will depend on where the drone is landed. The 2 1/2-ton drone transporter truck is normally used to retrieve the drone when it lands in the desired recovery area. When the drone is landed at the launch area, a drone litter can be used for retrieving. If a drone lands outside of the desired recovery area, a 1/4-ton recovery truck (fig. 62) should be dispatched to the suspected landing area. The terrain will ultimately govern the type vehicle which must be used for recovery.

a. The recovery team normally will consist of four or five men from the maintenance area. The team should have a radio, compass, and map of the local area at all times. During a normal recovery, the recovery team can operate efficiently with a vehicle and a radio for communications. However, when the drone lands in an area other than the desired recovery area, additional equipment may be needed.

- (1) If the drone or the parachute lands in a tree, the recovery team may need a 2½-ton transporter with winch, tree climbing set, about one hundred feet of ¾-inch diameter hemp rope, and one axe.
- (2) In mountainous or swampy terrain the drone may have to be carried some distance on the litter. A portable radio should be carried with the team. At least five men are required for the recovery team: four to carry the drone fuselage on the litter, and one to carry the parachute retrieving bag, the drone wing assembly, and to pack the radio.
- (3) If the recovery team is unable to locate the drone, an observation aircraft may be requested to locate the landed drone and guide the recovery team to the area.
- (4) A cargo helicopter with winch or hoist may be used as an alternate means of recovery from inaccessible areas.

b. In a combat situation, the recovery of a drone that has landed in an undesired area may be extremely dangerous. The recovery team may encounter guerrilla activity and be subjected to unexpected enemy fire. The team must be adequately armed when making this type recovery, since it may be necessary to engage in a withdrawal fire fight. If there is a fire fight after arrival at the landed drone, every attempt possible should be made to recover the camera. If the situation permits, retrieve other components that can be hand carried; i.e., the AN/DPN-62V transponder beacon, wing assembly, gyroscope, etc. Destroy whatever parts are left of the drone by the best means available (ch. 11).

c. The following steps are necessary in drone recovery:

- (1) A guide is used to direct the driver of the drone transporter through wooded areas. The transporter has a large welded steel frame which is easily damaged by trees in wooded areas. The ground must be checked for condition to support the transporter.
- (2) On arrival at the drone landing site, place the power switch and main junction box ignition switch in the OFF position.

Caution: If the explosive squib (quick-release device) failed to fire, it must be fired before effecting recovery.

- (3) If the drone was flown with a transponder beacon, remove the beacon cover, the AN/DPN-62V transponder beacon, and the camera. This immediate action is necessary to obtain the maximum speed in photographic processing. Take the camera to the photographic processing unit as soon as it has been removed.
- (4) If the drone was flown with the radar reflector pods, disconnect them from the wing.
- (5) Remove the wing assembly to prevent damage and to facilitate loading.
- (6) If the propeller is not broken, remove to prevent damage during handling.
- (7) If the drone fuselage has been damaged, dump any remaining fuel in the fuel tank by removing the filler cap and inverting the fuselage. Care must be taken to prevent damage to tail surfaces and engine assembly.
- (8) Retrieve the parachute. To prevent snarling of suspension lines, stretch the parachute out and braid the suspension lines. Next, twist the canopy and roll the canopy and suspension lines. Store in a parachute retrieving bag for transporting.
- (9) Load the drone, wing, pods, and parachute retrieving bag on the transporter.
- (10) Return the drone to the launch area if it is to be prepared for another flight.

d. Brackets for mounting a drone litter can easily be fabricated locally and used on a 1/4-ton truck to provide a small, highly mobile recovery vehicle. (For details of the 1/4-ton recovery truck, see appendix III.) Figure 62 shows the truck ready for use. Four men are required for the recovery team when using this truck. When moving through a wooded area, a guide is required to direct the driver. Except for the loading procedure, the procedure for the recovery is the same as for the drone transporter (*c* above). Figure 63 shows the drone mounted on the 1/4-ton recovery truck ready for transport.

- (1) When loading the drone on the 1/4-ton recovery truck, place the drone fuselage on the drone litter first, then place the litter with the drone fuselage on the loading brackets.
- (2) Place the wing in the wing rack.
- (3) Load the propeller and parachute.

Caution: Extreme care must be taken when operating in mountainous terrain. A maximum speed of 30 miles per hour is possible on improved roads only.

e. If the drone was damaged during the previous flight to the



Figure 63. Truck, 1/4-ton, with recovered drone.

extent that it cannot be repaired in the launch area, the recovery team will return it to the maintenance area.

33. Retrieving in Water

Flight operations performed over, or in the vicinity of, a body of water may result in a water landing because of loss of control or malfunction of drone components. In most cases, the film in the camera will be destroyed once the drone is immersed. The drone should float for about 1 hour after a water landing; floatation is provided by floatation blocks in the wing. A helicopter, provided one is available, is the most efficient means of water recovery. Drone recovery by boat requires one large boat or two small boats large enough to accommodate the drone. Some types of landing craft could also be used. After water retrieval, the following procedures must be used.

a. Salt Water Recovery.

- (1) Remove the battery, wing, engine, antennas, and camera from the drone.
- (2) Open all compartment doors and stand the drone on the engine mounts.
- (3) Flush the interior of the drone with fresh water. Make sure that all pockets are thoroughly flushed.
- (4) Allow the drone to drain completely by holding it in first the horizontal and then the vertical position.

Caution: It is essential after recovery from salt water that the drone be flushed IMMEDIATELY with fresh water.

- (5) Use compressed air (if available) to blow the water out of the pockets.
- (6) Wipe the fuselage thoroughly to remove all moisture.
- (7) Drain the fuel tank by removing the drain plug.
- (8) Disconnect the internal fuel line through the tank inspection hatch by unclipping the line from the bulkhead, and withdraw the line through the flange in the front bulkhead of the tank.
- (9) Apply compressed air to the fuel line opening until all moisture is removed from the tank. Blow out the fuel line and flush with light oil.
- (10) Reinstall the fuel line.
- (11) Flush, or wash with clean fresh water, each of the previously removed drone components; then dry them thoroughly.
- (12) Flush all electrical connectors thoroughly and then dry them. Check the junction boxes for salt water entry; flush and dry them if necessary.
- (13) Remove the magneto, carburetor, spark plugs, and crankcase drain plugs from the drone engine.
- (14) Immerse or wash out the crankcase and engine components with clean, fresh water.
- (15) Clean all parts and areas with kerosene or a gasoline and oil mixture. Dry thoroughly.
- (16) Reassemble the engine and, with the propeller installed, run it for at least 5 minutes.
- (17) Rinse the parachute in fresh water for at least 10 minutes. Clean the shrouds and connectors thoroughly.
- (18) Without wringing, hang the parachute to completely dry (allow at least 48 hours).

b. Fresh Water Recovery. Treatment of the drone and its components after immersion in fresh water is the same as the treatment after immersion in salt water (*a* above). However, it is not necessary that flushing of the drone and components be done immediately.

c. Repair of Components. If the drone components have been damaged by water, refer to appropriate TM's for detailed information on repair.

CHAPTER 7

TRAINING

Section I. GENERAL

34. Scope

This chapter includes requirements for advanced individual, section, combined, and concurrent training of the aerial surveillance platoon. For maximum effectiveness, this training must be as realistic and practical as possible and must emphasize the many necessary safety precautions.

35. Individual Training

a. Basic Combat Training Phase. The basic combat training phase is outlined in ATP 21-114.

b. Specialist (MOS) Training.

- (1) Specialist training requirements for specific MOS for personnel assigned to units employing drone aircraft are outlined in AR 611-201.
- (2) The U. S. Army Combat Surveillance and Target Acquisition Training Command conducts the following courses necessary for MOS qualification:
 - (a) Drone airframe and engine mechanic's course (drone aircraft crewman, MOS code 105.1, 105.6, and 105.7).
 - (b) Drone aircraft controller's course (drone aircraft crewman, MOS code 105.6).
 - (c) Drone aircraft control system mechanic's course (drone aircraft control system mechanic, MOS code 209.2).
- (3) Normally, personnel assigned to the drone section are specialists who have previously received school training. However, during a period of mobilization when sufficient school-trained personnel are not available, on-the-job training may be necessary.
- (4) With a sufficient amount of on-the-job training, experienced OQ-19 drone target aircraft airframe and engine mechanics can transition to the SD-1 drone aircraft. The OQ-19 drone target aircraft control system mechanics will have extreme difficulty transitioning and should attend the school course on the SD-1 drone. Usually the OQ-19 control system mechanics are not as skilled in basic electronics as SD-1 control system mechanics are required to be. With approximately 3 hours of drone

flying time, OQ-19 drone controllers can transition to the SD-1 drone controllers.

c. Training After Unit Assignment. Personnel arriving from the school have received minimum specialist training. Continued on-the-job training conducted concurrently with the unit training program is necessary to achieve and maintain proficiency.

36. Section Training

Section training is closely related to individual training. It follows current Army training directives and is accomplished concurrently with the fulfillment of the unit's mission. Section training develops the teamwork essential for optimum efficiency of operation. To achieve peak training efficiency, the 100-flight training program suggested in appendix IV should be followed.

37. Training With the Aerial Surveillance Platoon

To facilitate the successful accomplishment of the support mission and achieve training realism, the aerial surveillance platoon conducts operational training. Subject to modifications imposed by training directives, training follows Army training programs (ATP's); its overall effectiveness is determined through the use of Army training tests (ATT's). These publications should be used as a guide for organizing the training program. For training guidance for the drone section, see appendix IV. For additional guidance for advanced unit training, see ATP 1-78E.

Section II. SPECIAL RANGE OPERATIONS

38. General

This section provides the unit commander with a guide for preparing standing operating procedures for governing drone flight operation on established ranges. It establishes responsibility for supervision and control of drone operations (including safety procedures) in order to insure proper observance of drone flying and recovery procedures.

39. Range Requirement

To provide realistic training and safety of operations, it is essential that a drone flying range be large enough for visual and radar control (recommended minimum dimensions are 24 kilometers by 12 kilometers).

40. Definitions

a. Range Control Officer. A commissioned officer assigned by the installation command to have control responsibility for all range operations.

b. Range Officer. A commissioned officer, from the unit conducting the launching, designated to coordinate and conduct the overall operation of the range during drone flying, to include radar and photo support.

c. Safety Officer. A commissioned officer or senior noncommissioned officer designated to assist the range officer in the conduct of range operations. He is responsible for adherence to drone operation safety procedures.

41. Responsibilities

a. Drone Section Commander. The drone section commander is responsible for the operations of the drone section while on the flying range. Range and safety officers will be designated by the appropriate headquarters (avn co, avn bn, and armd cav rgt). He will assure that designated range and safety officers understand and comply with the operating safety procedures.

b. Range Officer. The range officer is responsible for the overall conduct of the drone range operations. He will—

- (1) Insure that radio or wire communications with the range control officer are installed and operating properly.
- (2) Notify the Army airfield tower via wire or radio prior to the first flight and at termination of the final flight period.
- (3) Insure that range flag is raised prior to opening range.
- (4) Command the recovery of all drones in case of failure of communication with the Army airfield.
- (5) Close the range at the end of the flying period.
- (6) Be responsible for physical arrangement of launch areas, to include proper handling and storage of ammunition and fuel.
- (7) Insure that a qualified first aid man is present at the launch site.
- (8) Insure that all personnel comply with the provisions of the standing operating procedures.

c. Safety Officer. The safety officer will assist the range officer with the overall operation of the range, with particular attention to the safety aspects of the operation.

- (1) He will conduct an inspection of the launch area each day prior to the first launching to insure that no unsafe conditions exist.
- (2) He will familiarize himself with the range boundaries by the use of major terrain features, and will insure that all drone operations are maintained within these boundaries during visual flying.

- (3) He will insure that, during radar flying, the radar units have been properly oriented and synchronized prior to the first launch of each day.
- (4) He will insure that all drone flying is conducted within the restricted area and that the flying area boundaries have been accurately placed on the radar plotting boards.
- (5) He will insure that all controllers are familiar with the range boundaries and maintain their respective drone flights within these boundaries during visual flying operations or that the target selector maintains visual contact when possible during radar operations.
- (6) He will remain alert for manned aircraft that may accidentally enter the drone flying area during drone flying. If this occurs, he will—
 - (a) Notify all controllers of the location of such aircraft.
 - (b) Command recovery of all airborne drones, if necessary for safety.
 - (c) Permit no launches until the range is clear.
 - (d) Notify the Army airfield control tower of such intrusions and give the following information: time, type of aircraft (if known), direction of flight, altitude, and aircraft number (if identified).
- (7) He will clear the range each day prior to the first launch.
- (8) He will advise the drone range officer of any unsafe conditions that he is unable to correct.
- (9) In case of a rocket motor misfire, he will take charge and follow the required procedures (ch. 9).
- (10) In the event a drone lands or crashes off the designated range area, he will—
 - (a) Immediately notify the drone section chief and range officer.
 - (b) Proceed to the area and immediately start an investigation in accordance with the provisions of AR 385-40. The designated claims officer should investigate before any equipment is removed.

d. Launcher Chief. The launcher chief will—

- (1) Decide whether or not the drone will be launched with respect to operating condition.
- (2) Insure that all safety requirements are met, including loading of drogue gun, installing rocket motors and shear pin, clearing area before starting engine, pulling lanyards and safety pins prior to launching and clearing the area completely prior to launch.
- (3) Supervise airframe and engine mechanics in the preparation of the drone.

e. Senior Control System Mechanic. The senior control system mechanic will—

- (1) Assist the launcher chief in his duties (*d* above) and assume these duties during his absence.
- (2) Supervise control system mechanics in the preparation of the drone.

f. Controller. The controller will—

- (1) Supervise all alternate controllers during flights.
- (2) Insure that the drone flight is kept within the boundaries of the flying area at all times.
- (3) Command recovery of drone at any time deemed necessary in the interest of safety, i.e., manned aircraft in the vicinity, loss of control, or loss of radar contact.
- (4) In the event of a flyaway—
 - (a) Immediately notify the Army airfield operations officer, range control officer, and the commanding officer of his parent unit and furnish the following information: time, last heading and altitude, and flight time remaining.
 - (b) Notify safety officer and range officer.

g. Recovery Crew Chief. The recovery crew chief will—

- (1) Accompany the recovery crew and supervise all retrieving operations.
- (2) Insure that all safety precautions are adhered to.

42. Operating Limitations

a. Drones will not be flown in the vicinity of troops at an altitude lower than that required to safely operate the CHUTE INSTANT button and land the drone in a normal attitude.

b. Drones will not be flown in the vicinity of firing ranges in actual use.

c. Except for specific training or photographic purposes, flights directly over troop concentrations will be avoided.

d. Unless authorized by the unit commander, flights will not be conducted off the designated range area.

e. The drone section range officer will coordinate with troop units training in areas adjacent to the launch site.

f. Drones will not be flown during periods of high air turbulence. The section commander is responsible for the decision to fly in marginal weather.

g. Drone section personnel WILL NOT enter impact areas to recover drones without the permission of the range control officer.

43. Range Operations

a. Drone flying will be conducted within approved flying areas

only. Tactical exercises during advanced stages of training should be conducted from various approved launch sites throughout the range area.

b. Drone personnel will be divided into normal tactical operating teams for field operations. These teams may or may not operate from the same area, depending upon the situation and mission.

c. The field operations will be subdivided into phases and covered by a mission plan.

d. The permanent launch site will be arranged as follows:

- (1) The tracking and plotting radars should be located on surveyed positions.
- (2) A ground control station will be located in the proximity of the radar units.
- (3) The launch area vehicles will be located in safety areas at least 15 meters to the side of the launch pad. No personnel or vehicles will be located forward of a drone during a launch.
- (4) Rocket motors, photoflash cartridges, and squibs will be stored in the Ordnance storage area located at least 150 meters from the launcher.

e. The drone will be recovered by radar in a predesignated recovery area.

f. Recovery teams will not move out to retrieve a drone without the permission of the range officer.

g. Drones will not be launched without the permission of the range officer.

h. Tactical launch sites will be designated in the mission request. The launcher chief and the controller at the launch site are responsible as follows:

(1) *Launcher chief.*

- (a) Physical arrangement of the tactical launch site.
- (b) Insuring that safety precautions are observed.
- (c) Insuring that the designated launch site direction of launch is observed.

(2) *Controller.*

- (a) Operations of the ground control station.
- (b) Obtaining permission to launch from the range officer prior to each launch.

Note. Cameras will not be used in cross-training of controllers.

44. Night Operations

a. During night operations all vehicles will use blackout lights and have a ground guide when travelling under blackout conditions.

b. The drone navigation lights will remain on during all drone *training* flights unless otherwise designated by higher headquarters.

c. For night operations, the drone section commander, range officer, safety officer, launcher chief, controller, and recovery crew chief will assume the same responsibilities as listed in paragraph 41. In addition, the launcher chief will—

- (1) When the engine is running and peaked and all final control checks have been made, direct the drone navigation lights to be turned on. This will be a signal for all members of the launch team to assemble at the safety area in the vicinity of the firing control box.
- (2) Make a physical check of the area (prior to pulling safety pins and connecting rocket motor igniter wires) to insure that no personnel or equipment are in the danger zone.
- (3) Remove safety pins and connect the rocket motor igniter wires.
- (4) Move to the firing control box, make a head count to insure that all members of the crew are present, and then proceed to launch.

45. Radar Tracking Operations

The following procedures will be followed in the event of loss of radar target *and* loss of visual contact:

- a. Immediately press INSTANT CHUTE button.
- b. After delay of 5 seconds, place the flight control box CARRIER switch to OFF.
- c. Report loss of drone to the range officer, safety officer, Army airfield tower operators, range control officer, and commanding officer of parent unit.
- d. Request a helicopter (if available) to locate drone and assist with retrieving operations, if necessary.

CHAPTER 8

TACTICAL EMPLOYMENT

46. General

a. The drone section will normally be employed in a general support role under centralized control of the aviation unit commander. The G2/S2 normally exercises general staff supervision over the aerial surveillance activities and drone collection effort to the degree and in the detail necessary to insure complete integration of the overall intelligence collection effort. For further details concerning combat intelligence, see FM 30-5. For further details concerning aerial surveillance-reconnaissance in the field army, see FM 30-20.

b. Employment of the drone section must be closely coordinated with the other sections employing aerial surveillance in order to avoid needless duplication of effort.

c. Drones are better suited for aerial surveillance and aerial target acquisition missions when weather or enemy air defense restricts the use of manned aircraft.

d. Drones are normally employed to obtain general and specific information within the supported units area of influence. They are also used to obtain detailed information over a specified area or to pinpoint targets within the supported units area of interest after coordination and approval with the element which has area of influence responsibility. The AN/USD-1 drone is not suitable for performing general area surveillance type missions.

47. Missions

The drone section performs aerial surveillance missions within the general categories indicated below. (For details of types and classifications of missions, see FM 30-20.)

a. *Specific Area Reconnaissance* (fig. 64). These reconnaissance missions are flown over a specific area or areas to gain specific information. These missions will normally be flown on a pre-planned basis to confirm or obtain more precise information of the enemy or terrain, based upon information received from other sources. This type mission will normally require small-scale aerial photographic coverage.

b. *Route Reconnaissance* (fig. 65). These missions are flown over specified lines of communications such as roads, railroads, and waterways. They will usually be flown on a point-to-point basis

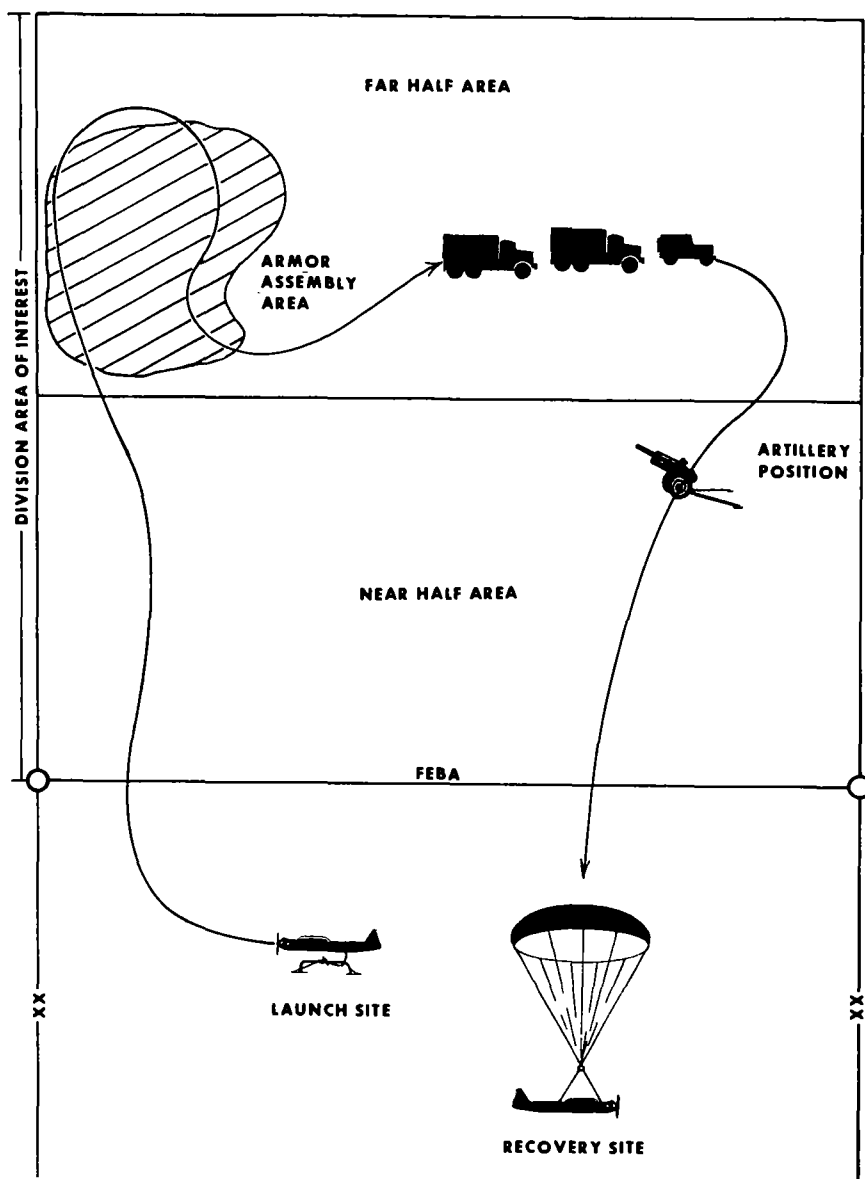


Figure 64. Specific area reconnaissance.

over the main transportation routes (fig. 66). This type of mission is flown to obtain information on—

- (1) Vehicle movements.
- (2) Status of roads, railroads, and bridges.
- (3) Changes in enemy troop disposition.
- (4) Enemy main routes of communication.

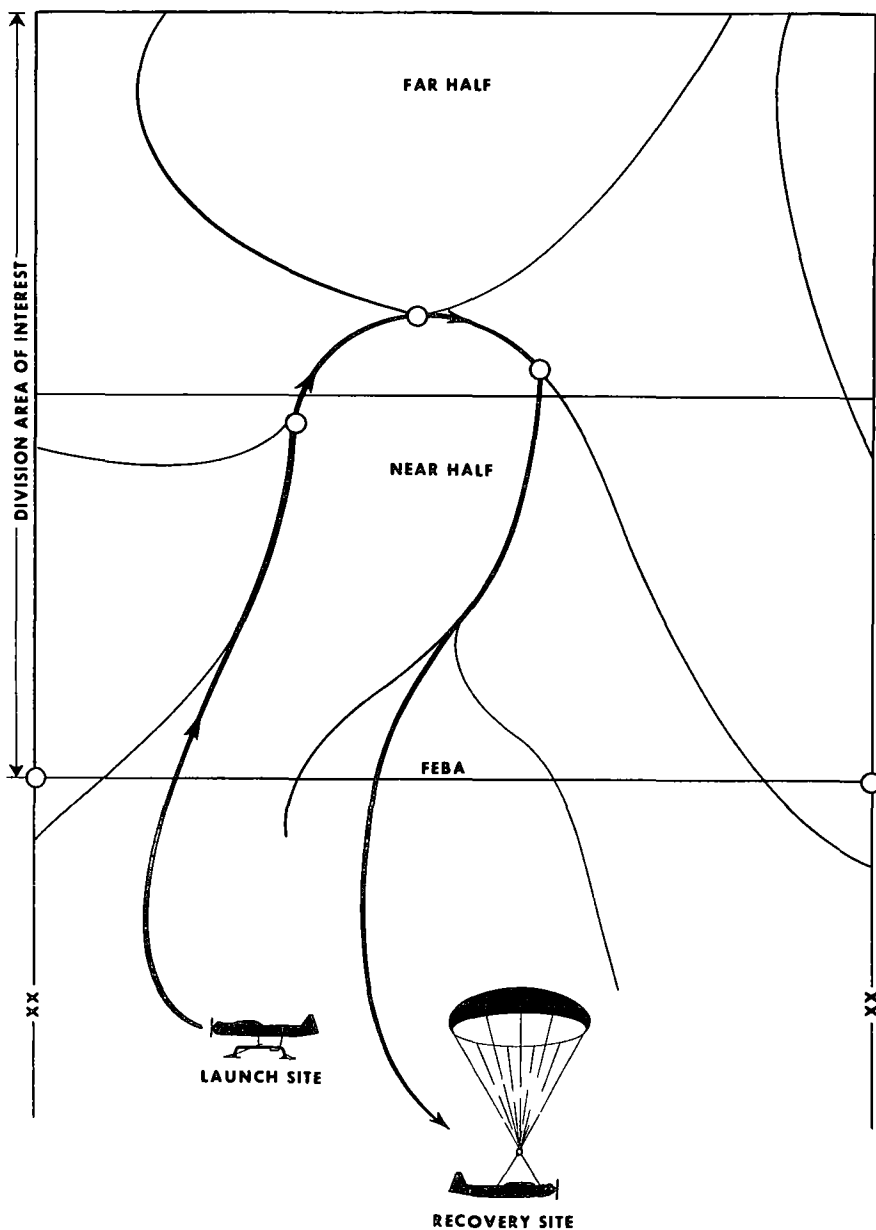


Figure 65. Route reconnaissance mission.

c. *Point Target Acquisition* (fig. 67). This type mission is flown over a designated area to obtain detailed information about a specific point target (e.g., enemy weapon positions, troop emplacements, terrain features, and assembly areas). Drone photographic reconnaissance can be usually relied on to confirm a sus-



Figure 66. Typical route reconnaissance.

pected target. This type of mission is also flown to make poststrike analysis on the effectiveness of both nuclear and nonnuclear weapons employment.

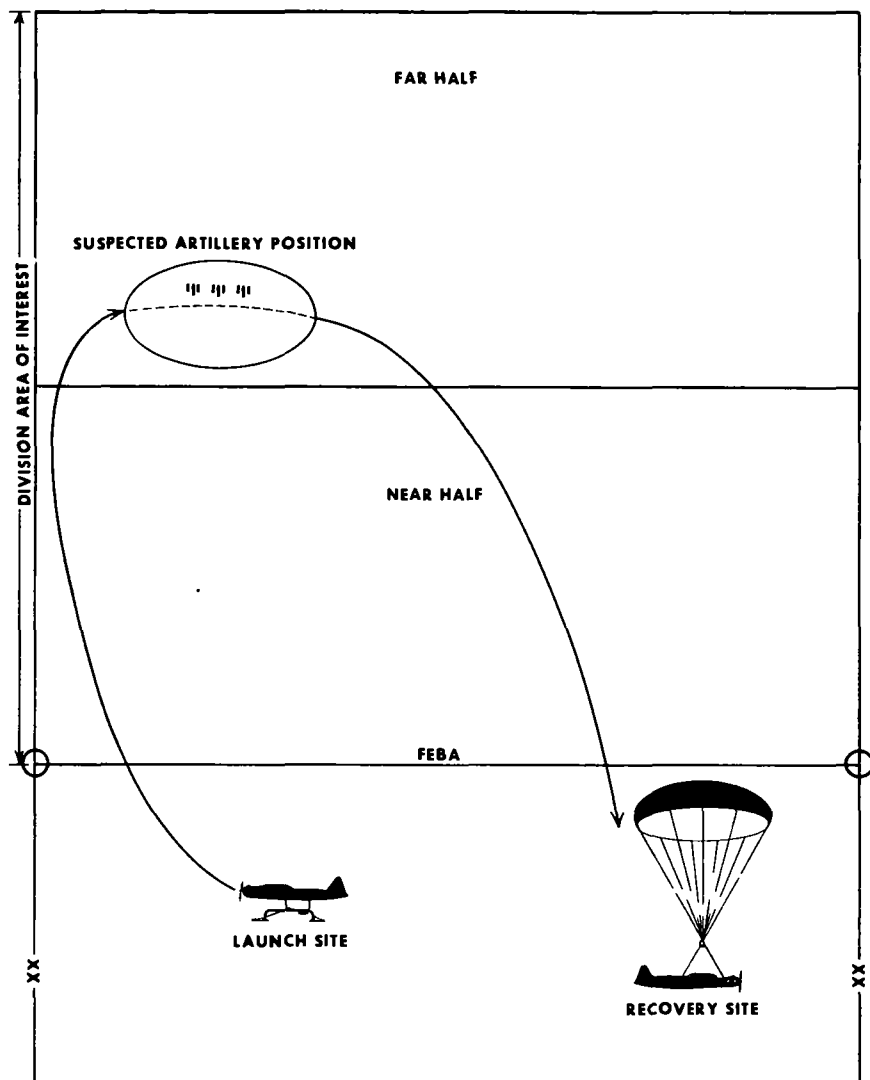


Figure 67. Point target acquisition.

d. *Other Possible Missions.* The SD-1 drone may, in the future, perform other possible missions which are dictated by the tactical situation and by the availability of other airborne packages. These missions include—

- (1) Television observation.
- (2) All-weather mapping with infrared or side-looking sensors.
- (3) Radiation detection.

- (4) Airdrop of small quantities of lightweight critical items (medical, etc.).
- (5) Remote delivery of electronic countermeasure equipment.
- (6) Decoy.
- (7) Infrared detection.
- (8) Radio relay and/or monitor.
- (9) Limited chemical, biological, and radiological agent employment.
 - (a) Fitted with explosives, the drone can be crashed into a suitable target.
 - (b) Fitted with a CBR agent, either the drone or its air-droppable package can be dropped into an enemy area.
 - (c) Fitted with a spray device, it can be used to disseminate a biological agent.
- (10) Psychological warfare (airdrop of special leaflets on point targets).

48. Mission Request Procedures

Aerial surveillance missions for the drone section may be originated by any element of the division—the various staff sections or higher, lower, or supporting units. The missions are divided into two categories—

a. Preplanned Requests. Preplanned requests usually allow at least 24 hours to complete planning and preparation before execution. The aerial surveillance requests are submitted daily, prior to a given time, to the division G2 through intelligence channels for coordination and integration into the surveillance plan. Mission requests are processed to the G2 air group of the tactical air support element in the force tactical operations center. If the requests are within the capabilities of Army aviation means, organic or attached to the force, and aircraft are available to perform the mission within the time desired, the requests are passed to the chief of the Army aviation element in the force tactical operation center for implementation. Requests which are not within the capability of Army aviation are approved by the chief of the G2 air group based on the tactical situation and established priorities. The approved requests are assigned a priority and passed to the Air Support Operations Center (ASOC) for implementation. If the aerial surveillance unit is attached to a subordinate unit of the division, preplanned mission requests are forwarded by the G2 air group to the commander of that subordinate unit. The sensor and aerial platform recommended for the mission will be assigned at the aerial surveillance unit level.

The basic criteria in determining the selection of a drone or manned aircraft are—

- (1) Type and detail of information desired.
- (2) Availability.
- (3) Capabilities.
- (4) Whether visual reconnaissance or surveillance is required.
- (5) Probable losses of manned aircraft due to enemy actions.
- (6) Enemy detection and electronic countermeasure capabilities.
- (7) Airspace coordination.
- (8) Radiation hazards.
- (9) Mission response time.

b. Immediate Requests. Immediate aerial surveillance mission requests may be assigned at any time. They usually originate quickly and cannot be planned for in detail in advance. Immediate mission requests are normally submitted by subordinate units direct to the G2 Air, via the air request net. The decision to execute is made by the G2/S2, considering the relative importance of the request and the surveillance capability of the platoon. The mission assignment is similar to the procedure in *a* above.

- (1) The platoon commander must be continually prepared to execute immediate request missions by retaining a portion of his capability (personnel and aircraft) in a ready status.
- (2) Immediate missions will be flown as soon as possible. A drone already airborne on a preplanned request mission may be diverted to higher priority targets if necessary.

49. Sensor Capabilities

a. General Aerial Photography. Aerial photographic reconnaissance is one of the principal means of collecting information which may be processed into intelligence. Raw information must be examined and interpreted before it becomes intelligence. This makes aerial photographs very useful because they provide up-to-the-minute information on any changes that may have been made to the terrain or to installations. For additional information about aerial photography, see TM 11-401 and Air Force Manual 55-6. The three basic types of aerial photographs are *vertical*, *oblique*, and *horizontal*.

- (1) *Vertical* aerial photographs are made with the lens axis of the camera perpendicular to the earth. This is the only type of aerial photograph the drone can take accurately. Also this is the only type of aerial photograph that can be taken at night because night operations require the use of an artificial illuminant. Vertical aerial

photography is generally divided into three types: spot photography, reconnaissance strip, and mosaic photography.

- (a) Spot photography consists of a single photo or stereoscopic pair of a particular installation or terrain feature (e.g., a highway bridge, the objective centered or pinpointed on the photo).
 - (b) A reconnaissance strip is a single flight line of overlapping photos taken at a constant altitude between two points (e.g., a strip along a railroad). The desired overlap is 60 percent for ease of stereovision. If the image motion compensator (IMC) setting is correct, this overlap is automatic.
 - (c) Mosaics are two or more reconnaissance strips, usually parallel, with side overlap of approximately 40 percent between strips (e.g., mosaic of a large town or battle area). Control of the drone is not accurate enough to consider mosaic photography a capability; however, with practice a controller may become sufficiently proficient in flying the drone on radar to fly a two or three-strip mosaic.
- (2) *Oblique* aerial photography is accomplished with the lens axis of the camera positioned between the vertical and the horizontal axis. Spot oblique photographs can be taken when the drone is in a turn; however, accuracy in taking obliques is very difficult and is not considered a capability of the AN/USD-1 drone because no oblique camera mounting is provided.
- (3) *Horizontal* aerial photographs are made with the lens axis of the camera horizontal to the earth. The drone has no capability of taking this type of aerial photograph.

b. *KA-20A Camera.*

- (1) *Description.* The KA-20A still picture camera (fig. 13) is a lightweight aerial reconnaissance camera designed for daytime use only in drones and light manned aircraft. For details of camera loading, installation, check-outs, normal operations, and operations under unusual conditions, see TM 11-6720-203-10.
- (a) The camera consists of two major parts, the magazine assembly and the lens cone assembly. The magazine assembly includes the mechanism assembly and the cover assembly. The mechanism assembly contains the film spool, the drive motor, and the image motion compensator (IMC) controls. The cover assembly con-

tains a knob fastener, IMC controls opening, the carrying handle, a data plate, and the film-remaining indicator. The lens cone houses the lens and shutter.

- (b) A film data plate is used for recording information on each frame of exposed film. The information data may be written on the plate with a grease pencil; once the information is recorded on the plate it should not be changed until the camera is unloaded. If a change is necessary, disconnect the lens cone and change the data; observe caution and only disconnect the lens cone in a subdued light area (i.e., inside a closed van, in a closed tent, or under a tarpaulin).
 - (c) An exposure recording dial is located behind the film data plate on the magazine section. This dial records the exposure number on each exposure up to 99 exposures. The dial is automatically reset and cannot be seen once the lens cone is attached to the magazine.
 - (d) A film remaining indicator, located on the cover assembly, indicates the number of feet of film remaining on the film supply spool.
 - (e) A film transport indicator (disc) is located on the magazine next to the power connections. It rotates as the film is being transported. An arrow on the disc indicates operation of the film transport mechanism.
 - (f) The camera has a shutter cycle counter located on the shutter cover plate. It indicates the total number of cycles performed by the shutter.
 - (g) A flight direction arrow is located on the side of the magazine assembly. It must point toward the front of the drone when mounted for flight.
 - (h) The KA-20A has two filters: a Wratten minus-blue No. 12 (yellow filter), and a Wratten No. 25A (red filter). For details on using the filters, see paragraph 50c.
- (2) *Capabilities.*
- (a) The KA-20A camera uses a variety of film types (par. 50b). Each roll of film is 9½ inches wide by 75 feet long and has a 10-foot leader and a 6-foot trailer. The film produces ninety-five 9- x 9-inch exposures.
 - (b) It has only two shutter speeds of 1/150 and 1/300 second, controlled by a knurled knob located in front of the lens opening. The shutter speed is set on the ground and cannot be changed while airborne.
 - (c) The diaphragm opening is fixed at f/6.3 and is not adjustable.

- (d) The camera has a fixed focal length distance of 6 inches between the lens and the film. The focal length is used to compute scale, altitude, and ground coverage.
- (e) There are six IMC settings on the KA-20A camera. These settings compensate for altitudes of 400, 800, 1,500, 2,000, 3,000, and 4,000 feet. A small motor transports the film at the proper altitude compensated speed as the drone passes above the ground at 200 miles per hour. When the IMC setting is set at the altitude being flown, it will time the shutter to open and close at proper intervals, allowing a 60 percent overlay on each photo. If the drone is flying less than 200 miles per hour, the overlap will be greater (i.e., 65 percent, 70 percent, etc.).

c. *KA-39A Aerial Camera.* The KA-39A still-picture aerial reconnaissance camera (fig. 14) is similar in size and shape to the KA-20A camera. For details of loading, installation, checkout, and operation under unusual conditions, see TM 11-6720-207-10. Its description and capabilities are the same as for the KA-20A camera except—

- (1) The lens opening is f/6.3, with an actual aperture of f/8 for the day mode and usable aperture of f/4 for the night mode.
- (2) In addition to the yellow and red filter, the KA-39A camera has a clear filter for the night mode of operation.
- (3) There are 16 IMC settings on the KA-39A camera; seven in the 200 miles per hour range and nine in the 100 miles per hour range. The 200 miles per hour range compensates for altitudes of 1,000, 1,500, 2,000, 2,500, 3,000, 4,000, and 5,000 feet. The 100 miles per hour range is used to take aerial photographs with the drone above 10,000 feet. This range is intended for use with light aircraft.
- (4) The KA-39A camera has an internal mounted vacuum motor instead of the externally mounted venturi used with the KA-20A. The venturi has a tendency to freeze when operating in icing conditions.
- (5) The KA-39A camera has a control box which must be used when the camera is used.
- (6) This camera is a component of the KS-53A camera system when it is used in the night mode of operation.
- (7) The KA-39A camera mounts and case are stronger than those of the KA-20A.

d. *KS-53A Camera System.* This camera system provides the drone with a night aerial photographic capability. It is capable

of taking 10 spot photographs at night or a 10-exposure night reconnaissance strip. The description of its components are in paragraph 10*b*(1) (*b*), installation of components is given in TM 11-6720-207-10, and the system checkout is included in paragraph 18*e*(3).

50. Daytime Use of Cameras, Films, and Filters

a. General. For quick computation of aerial photographic problems concerning KA-20A and KA-39A photographic mission planning, see table I and table II in appendix V. For details on mission planning see paragraph 51. For additional information on mission planning and formulas used in solving aerial photographic problems, see TM 11-401, TM 11-6720-203-10, TM 11-6720-207-10, and TM 30-245. Factors in mission planning that must be determined prior to loading the camera are—

- (1) Photo scale desired, usually stated in mission request.
- (2) Ground coverage required, usually stated in mission request.
- (3) Altitude required to be flown over target. This will usually be a result of the photo scale, unless prescribed in the mission request.
- (4) Type of vertical aerial photograph required, e.g., spot photography or reconnaissance strip.
- (5) Type of film (*b*(1) below).
- (6) Shutter speed. This will be determined by the amount of light available and the film used.
- (7) Amount of film required. This will be determined by the altitude flown and the ground coverage required.
- (8) Type of filter (see par. *c* below).
- (9) Information required for the data strip. The Army follows Air Force Regulations 95-7 and -7A for titling aerial reconnaissance photography (fig. 74, app. V).

b. Use of Film. Photographic film is the “ammunition” for the camera. Just as aerial photography requires special cameras, it also demands film adapted for aerial use. The film used by the drone section will be mostly Class L, Class N, and infrared. For additional information concerning other films, see TM 11-401 and Air Force Manual 55-6. There are two types of aerial photographic film in general use by the Army as given in (1) and (2) below.

- (1) *Panchromatic film.* This film is sensitive to the entire visible spectrum but is not sensitive to infrared. The panchromatic films in standard usage by the Army for aerial photography fall into four groups: Class L, Class N, aero ektachrome and camouflage detection. Class L film is a high-speed panchromatic emulsion used for day-

light photography. Aero Ektachrome film is the standard color film used in aerial photography. Camouflage detection film is a color film with an additional infrared sensitive layer.

- (2) *Infrared film.* Infrared photography may be used when haze conditions are too severe for aerial reconnaissance by conventional photographic means. Infrared film has a high sensitivity to the red and infrared light extending considerably beyond the visible spectrum. It is also sensitive to blue light. A red filter must be used with infrared film to eliminate the blue light; it allows only the red and infrared light rays to expose the film. This sensitivity allows the film to record through haze and produce clear pictures on a dull overcast day.

c. Haze Effects and Use of Filters.

- (1) Haze is caused by dust or water vapor particles scattering the light rays. It is usually present and its effect becomes greater at higher altitudes (in proportion to the increase in distance). Haze destroys details in the photographic image by diffusion of the light rays and veiling of the photographic image. This appears on the photograph as a fogged effect. The effects of haze may be minimized by use of the applicable blue absorbing filter over the aerial camera lens or by the use of infrared photography. There is no effective way for photography to penetrate fog or smoke.
- (2) The filters used to control the effect of haze are of the blue and ultraviolet absorbing type, ranging in color from light yellow to red. A filter will permit its own color to pass through, but will partially or completely block all of the other colors (e.g., a red filter will pass all of the red rays and will block out all of the blue and most of the green rays). Filters are far more important in aerial photography than in terrestrial or ground photography. Even when the atmosphere seems perfectly clear from the ground, aerial observation will show a slight haze which increases in density with altitude. Table III, appendix V, lists the filters that can be used with Class L films for different haze conditions. For additional information on use of filters, see TM 11-401.

d. Film Rating. Army films are rated by the American Standards Association (ASA) film index according to the amount of light required to properly expose the film. Class L film has a speed index of 100 and Class N film has a speed index of 200. Infrared film does not possess the same exposure scale as standard emul-

sions; therefore, any given ASA indexes should be considered as guides only.

e. Film Storage. Normal storage temperatures for aerial films are 45° F. for Class N and 50° to 60° F. for Class L. Improper storage temperatures are harmful to film. Films should be allowed to come to normal room temperature of 70° F. for 12 to 24 hours prior to exposure.

f. Film Expiration Date. The military expiration date for aerial films is 12 months after the manufacturing date for Class N and 18 months for Class L film. Aging has an adverse effect on aerial film. For best results, aerial photographic films should be used before the expiration date.

51. Mission Planning

The mission of a surveillance drone is to perform accurate aerial reconnaissance of a designated area within its range capabilities. The planning phase includes all activities prior to the launch. The maximum reconnaissance capabilities of the drone section should be used in mission planning and an established SOP for operations of the drone section should be followed. The success of a mission is dependent upon the extent and thoroughness of planning and coordination between the supported and supporting commanders.

a. Planning Considerations. The planning phase is initiated with the assignment of a specific mission to the aerial surveillance platoon. The mission request will include target location (grid coordinates), photographic scale required, type of coverage desired, target description, time of mission, route or area to be flown, friendly operations, and other pertinent information. Normally, mission planning will be accomplished by the headquarters of the aerial surveillance platoon. Planning will be accomplished by the drone section if it is operating in support of other than its parent unit. Known enemy countermeasure capabilities and limitations, enemy defenses, sensor capabilities, location of launch and recovery sites, *air traffic regulations and restrictions*, and flight direction and altitude must be considered in mission planning. Specific items that must be determined for mission planning are—

- (1) *Target location.* Grid coordinates will usually be used to designate the target. The imagery-producing drone flight will be tracked by radar to make a flight path overlay which records the starting and stopping points of the sensor. This overlay is used in interpretation analysis of the photographs. Ultimate target location consists of the three dimensional positioning of the target by azimuth or grid coordinates, distance, and altitude.
- (2) *Priority.* A priority will be assigned to each mission

with the highest priority (priority I) taking precedence. Priority is assigned according to the urgency and importance of the requested information of the requesting command. This is influenced by the unit mission, tactical situation, and the use for which the surveillance is intended.

- (3) *Target description.* A brief description is required to help determine the coverage required and the best method of surveillance. The description should include as much information as possible about target composition, size, and other pertinent information.
- (4) *Photographic scale and coverage.* This information should be given in the mission request. If it is not given, refer to target breakdown in TM 11-6720-207-10; also the nomograph will help determine the coverage when the scale is given. As a general rule, a scale of 1:10,000 is sufficient for target identification while a scale of 1:5,000 provides for detail interpretation of such targets as electronic communications and enemy gun targets.
- (5) *Time on target.* In most cases the mission request will state the approximate time over target. In some cases, time desired to obtain imagery results will be requested to the minute; the drone section should be capable of meeting the desired time over the target within one minute.
- (6) *Delivery time of film.* Each mission request will indicate a time that the surveillance information is no longer of value to the requesting organization. The delivery time of the film to the G2 Air representative or the photo interpreters must be met.
- (7) *Airspace restrictions.* The flight operations center (FOC) may have certain restrictions on airspace within the operating radius of the drone. For this reason the drone section must closely coordinate with the FOC and file the drone flight plan at the earliest possible time before each mission. Each drone mission must have flight approval clearance from the FOC prior to launch.
- (8) *Weather.* Weather is one of the most important elements of mission planning. The latest weather reports will be available from the G2/S2 local Air Force weather detachments and the division main airfield. Weather will determine the methods of deployment, control, type film required, and whether or not the mission will go.
- (9) *Location of the tracking and plotting radars.* The drone section commander and the controllers must know the

radar sites at all times, since their deployment will directly affect mission planning. In some cases, one or both tracking and plotting radars will be directly attached to the drone section. Their deployment is discussed in paragraph 52 below.

- (10) *Recovery sites.* Recovery sites must be selected during mission planning. If possible, a reconnaissance should be made of the site before completing the mission plan. Recovery site selection will be as described in chapter 6.
- (11) *FEBA penetration and reentry points.* The FEBA penetration and reentry points may or may not be given in the mission request. If at all possible, these points must be at positions most advantageous to the mission and the situation.
- (12) *Method of control and communication.* These two factors must be determined before the mission plan is complete. Methods of control will be determined by which radar will track the mission and when and where transfer of control will be initiated. (See ch. 5 for more details.) The type of communication to be used during the mission will be determined and action will be taken to see that each type of net is fully operational. For more direct control of each mission, it is recommended that the drone mission data sheet (app. II) be used for each drone mission. The controller must receive the mission data sheet at the radar site prior to the desired launch time. A complete data sheet must accompany all film through processing and must accompany the resulting imagery to the photographic interpreter.

b. Responsibilities of Personnel.

- (1) *Aerial surveillance platoon leader.* The aerial surveillance platoon leader, assisted by the drone section commander, is responsible for implementing that portion of the aerial surveillance plan concerned with employment of the drone section. He is also responsible for drone mission planning and the proper employment of the entire section.
- (2) *Drone section commander.* The drone section commander is responsible for the proper employment of the section and any attached elements. He is directly responsible for the launch of each drone and the complete performance of each mission so far as possible.
- (3) *Drone controller.* The drone controller is responsible for effective mission performance. He must be aware of the

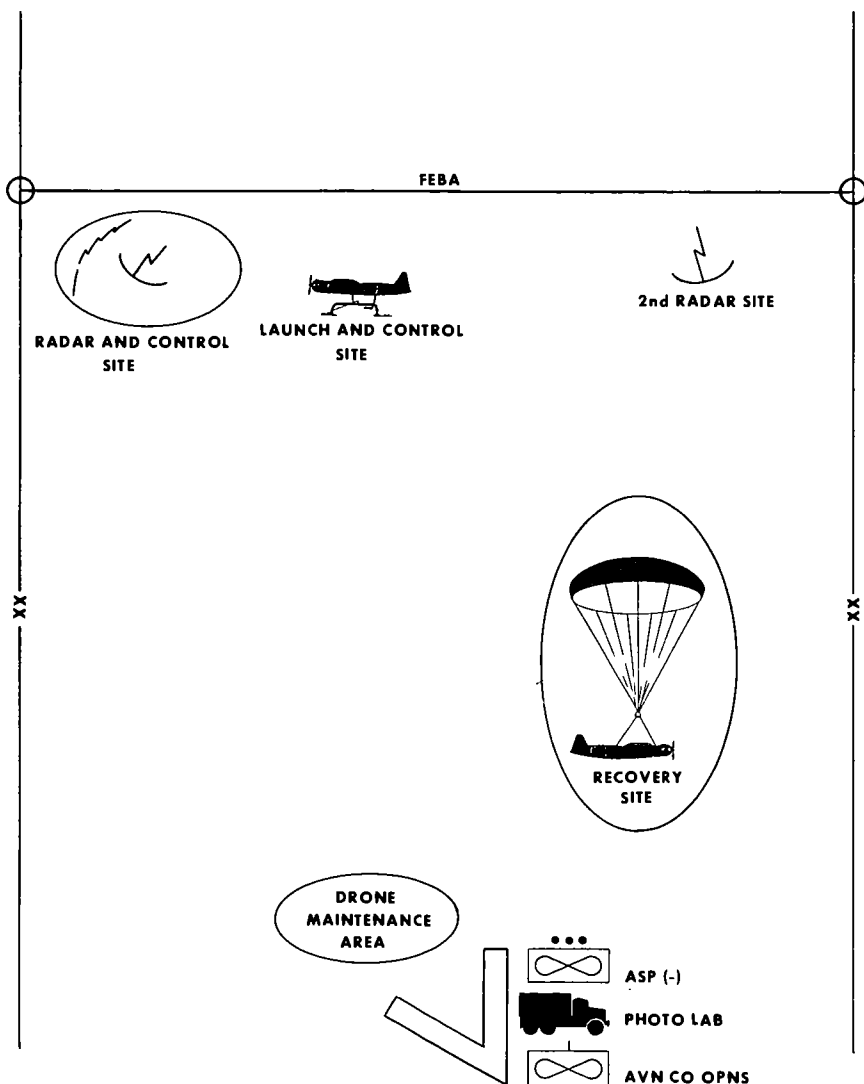


Figure 68. Deployment of the drone section.

objectives and the difficulties and limitations imposed by terrain, weather, lighting, etc. on the proposed mission.

52. Deployment of the Section

The drone section will normally be employed in general support of the division; however, it can be attached to a subordinate unit of the division for specific missions. Normally the section will be highly dispersed into three or more elements: launch team, main-

tenance and/or recovery team, and controller with the tracking and plotting teams. Figure 68 illustrates a typical deployment.

a. *Tracking and Plotting Radar Sites.* The radars will be deployed separately as far forward as possible. The sites should take advantage of existing terrain features such as hills and mountain tops or their military crest. On relatively flat terrain they must be positioned in open or lightly wooded terrain, if possible, and must depend on camouflage nets and similar material for protection. Figure 69 shows a typical tracking and plotting radar site.

b. *Control Sites.* Control sites will normally be located at the radar site, launch site, or recovery site and must be well camouflaged and concealed.

c. *Launch Positions.* Launch positions will be as far forward as possible. The launcher must be camouflaged and the drone launched from beneath camouflage nets or from the edge of wooded areas. Fuel, ammunition, and vehicles must be dispersed in the woods; yet be readily accessible for efficient operations. Launch sites may be located at small clearings, narrow valleys between mountains, small canyons, and similar places.

d. *Tactical Flying.* Tactical flying is any method of deploying the drone to deceive the enemy in order to accomplish the mission. The drone should be flown at a low altitude in order to achieve an element of surprise and to keep below the radar detection line. It should penetrate and reenter the FEBA at different points. If the air traffic is heavy in the launch area or if the area is overcast, drones can be employed safely with other aircraft by either of two methods:

- (1) A cylinder of air space is restricted to manned aircraft for a radius of 1,500 meters around the launch site. The drone can then be launched and climbed to altitude within this cylinder and then depart on its cleared route. When it returns for recovery, it descends in this cylinder and is recovered at the recovery site.
- (2) The controller climbs the drone in-sight as far as possible. He continues to climb to altitude while proceeding on course.

e. *Camouflage.* Camouflage of the drone by painting it a soft mottled-gray or sky blue is recommended. The colors used should be according to the type of sky prevalent for the particular mission.

f. *Recovery Position.* The recovery operations should be completed rapidly and the crew should depart immediately with the drone. The recovery site should be selected as described in chapter 6.

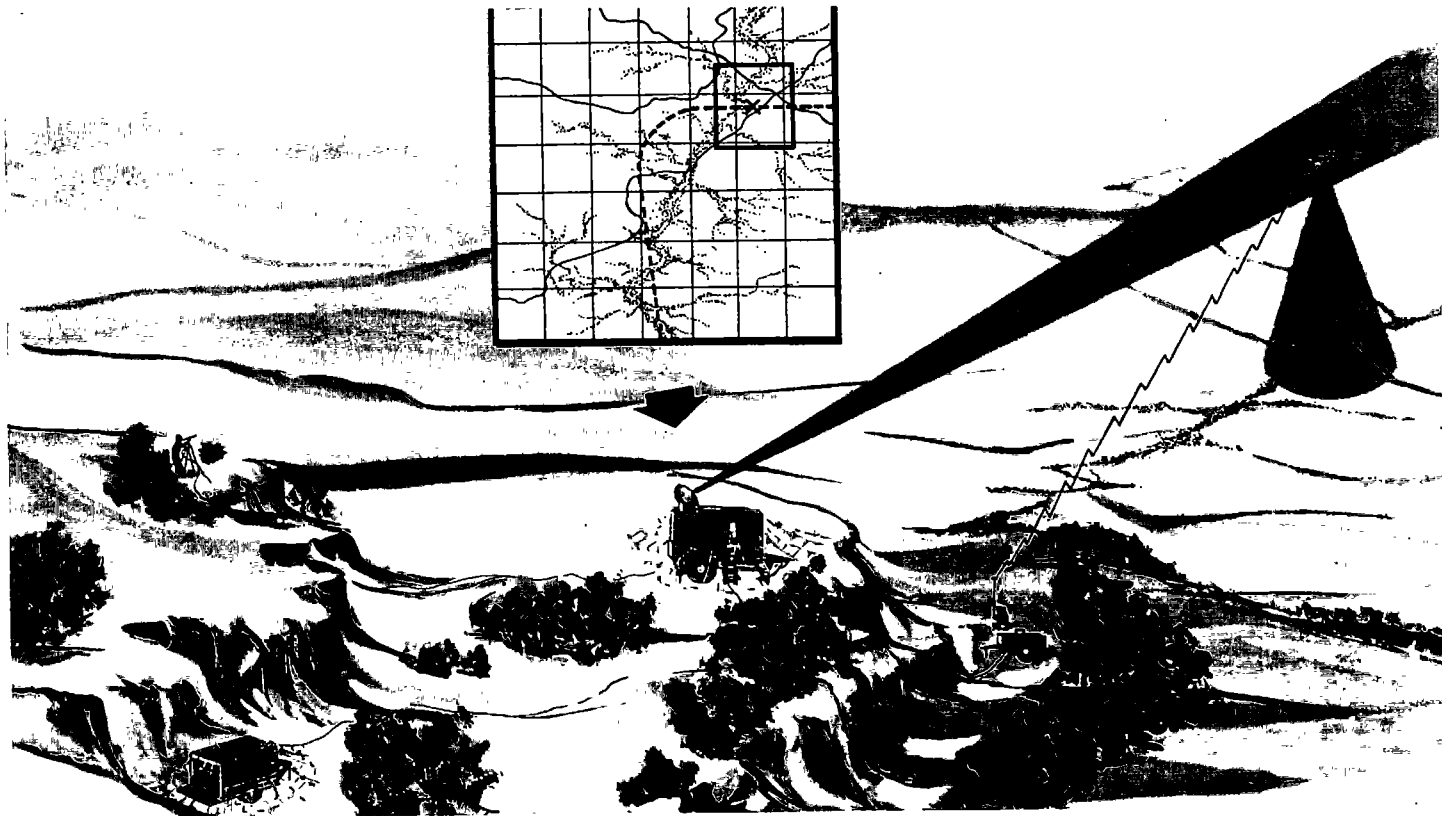


Figure 69. Typical radar control site.

53. Displacement of the Section

a. *Normal.* The section will displace in the manner described in the section SOP. Normally the whole section will displace together; however, this will depend on the operation site location.

b. *Rapid.* For rapid displacement, the launch team will be the first element to move. The controller and the control station must move with the launch team or the radar teams. Normally the maintenance team will displace after the other elements are in position.

c. *Continuous Operation During Displacement.* If the section is required to displace during missions, one ground control station will move with the other tracking and plotting team. Another launch team will be formed from the maintenance team and will move forward as directed by the section commander. The section chief will remain at the old location to complete the missions already planned. The maintenance team will be formed from the old launch team and will move the maintenance area forward as directed.

54. Photographic Laboratory Support

A laboratory darkroom, AN/TFQ-7 or ES-29, is organic to the aerial surveillance units and may be further assigned to the drone section, depending on the requirements and the tactical situation. It will be available for processing the film exposed by the drone section. Employment of the dark room is as designated by the aerial surveillance unit commander. For more details about the photographic laboratory, see TM 11-401.

CHAPTER 9

SAFETY

55. General

Personnel must be made aware of the dangers inherent in the drone system, with safety precautions integrated into all training including safety rules, correcting or reporting unsafe conditions, and making use of protective devices (e.g., goggles) as required.

56. Responsibilities

a. Drone Section Commander and Section Chief. The drone section commander is responsible for orientation of new personnel, safety training, enforcement of safety regulations, investigation of accidents, preparation of accident reports, and conduct of safety meetings. He is responsible for the safety of personnel and for establishing safety procedures and SOP's. He is assisted by the section chief. SOP's must be established to guide the section during malfunctions peculiar to the drone guidance system. Transmitter frequency jamming and interference such as spurious commands (causing flyaways or an uncontrollable drone) are examples of drone safety problems.

b. Controller. The controller is responsible for controlling the flight of the drone. He will insure that drone flights are not made to the extreme range of the particular tracking and plotting radar employed. The controller will command recovery of the drone at any time deemed necessary for safety (manned aircraft flying within range of the drone, loss of control, etc.). If a flyaway occurs, he will immediately notify the control tower of the nearest Army airfield or the air traffic control facility and give the following information: time, direction last heading, altitude, and flight time remaining. He will also request the control tower or air traffic control facility to use any search radar or ground controlled approach radar available to search for the drone (if still airborne) so that aircraft in the area can be warned of the flyaway.

c. Launcher Chief. The launcher chief is responsible for seeing that all safety requirements are met including loading of drogue gun, installing rocket motors, installing shear pins, clearing area before starting engine, and pulling lanyards and safety pins prior to launch.

Warning: Goggles must be worn by all members of the launch crew to protect the eyes.

d. Senior Control Systems Mechanic. The senior control systems mechanic is responsible for safety in the maintenance area.

57. Night Operations

Tactical night operations are the same as outlined in paragraph 44, except that drone navigation lights are not used. The flight operations center must clear all night missions from the launch point to the recovery site.

58. Failure of Parachute Commands

If actuation of the INSTANT CHUTE button fails to deploy the chute and the drone engine stops, the controller must take immediate action as described in chapter 6. This situation is very dangerous to personnel on the ground because the usual result is a controlled forced landing of the drone. Planning must provide for this contingency.

59. Fuel Handling Safety Procedures

Caution: Smoking is prohibited within 15 meters of the drone or fuel supply trailer.

a. Place a carbon dioxide fire extinguisher (normally the fire extinguisher from the launch area trailer) within 6 meters of all refueling or fuel mixing operations.

b. Prior to fueling, make certain that the power switch is OFF, that external power is disconnected from the drone, and that the ground lead clamp is connected to the drone.

c. Clean off all fuel that may be spilled over the fuselage. If an appreciable quantity has accumulated on the ground, completely cover the saturated portion of the ground with earth.

60. Drogue Gun, Squib, Photoflash Cartridge, and Rocket Motor Safety Procedures

a. Storage and Handling.

- (1) *Drogue gun.* Handle and store the drogue gun cartridge (which contains 14 grains of powder) as any rifle or pistol cartridge is handled and stored.
- (2) *Squibs.* Do not remove squibs (which contain 2 grains of powder) from sealed plastic bag until ready for use since the squib is sensitive to moisture and may malfunction after exposure to the air. Do not remove the static ground wire until ready to connect the squib leads to the input connector cable.
- (3) *Photoflash cartridges.* Store photoflash cartridges as indicated in TM 9-1903. Observe the following additional precautions:

Caution: Smoking is prohibited within 15 meters of photoflash cartridges.

- (a) Expend all photoflash cartridges prior to recovery. If the drone is recovered with unexpended cartridges, remove the cartridges immediately.
 - (b) Do not disassemble photoflash cartridges.
 - (c) Store photoflash cartridges in a dry, well-ventilated place out of the direct rays of the sun, and protect against excessive or variable temperatures.
- (4) *Rocket motor M-3.*
- (a) Protect rocket motors from the direct rays of the sun at all times. Avoid storage where temperatures range beyond the storage limits specified.
 - (b) Avoid subjecting rocket motors to rapid and extreme temperature changes, to severe shock (e.g., dropping), and other improper handling procedures which might crack or break the propellant causing dangerous pressures when fired.
 - (c) Avoid breakage of moisture resistant seals until the unit is ready to be used.
 - (d) Do not disassemble rocket motor or its components.

b. Installation.

(1) *Drogue gun.*

- (a) Do not remove the cartridge from plastic bag until ready to install into the drogue gun.
- (b) Examine the safety pin in the firing mechanism to insure the end is bent slightly to prevent premature release of the firing pin.
- (c) After installation, *do not* exert force on the safety lanyard until the firing pin lanyard has been installed. (Once the drogue gun has been armed, it will fire when the parachute door opens.)
- (d) Never stand in the line of fire of the drogue gun.

(2) *Squibs.*

- (a) Keep the squibs packaged until ready for use.
- (b) Disconnect all power supplies and input switches from the drone while installing the squibs.
- (c) Connect the squib leads to the input connector cable, then remove the static ground wire between the squib leads.

(3) *Photoflash cartridges.*

- (a) Check the photoflash ejectors prior to each mission in accordance with the provisions given in paragraph 18.
- (b) Do not install photoflash cartridges until the last step of drone preparation (par. 22).

- (c) Install the photoflash cartridges in accordance with procedures in paragraph 22e.

Warning: The flare arming switch is a safety device which is normally actuated by inertia caused by drone takeoff. Never bypass this safety device for any reason other than to perform camera and photoflash cartridge checkout. Always be sure that the reset switch has been depressed after the checkout is completed. Failure to disarm the arming switch can result in premature photoflash cartridge ejection and cause serious injury to personnel.

- (4) *Rocket motors.* A safety switch operated by an arming lanyard prevents premature detonation of the individual rocket motors.
 - (a) Install rocket motors in their carriers just prior to use. If rocket motors are not used, remove from the carriers and replace in their box before storing.
 - (b) Exercise extreme care during the installation of the rocket motor to insure completeness of mounting and attachment. A rocket motor improperly or insecurely installed may break loose when being fired and travel at a high velocity on an uncontrolled and unpredictable flight.

Note. The launcher chief will remove the shunt wire from the rocket motor igniter plug only in preparation for launching.

- (c) After installation on the drone, if the drone is not immediately launched, cover the rocket motors to protect them from the sun. Safe firing temperature limits are marked on each rocket motor. Firing at temperatures above the "safe limit" may produce dangerously high pressures within the chamber. Firing at temperatures below the safe limit may cause erratic flight and duds or may produce dangerously high chamber pressures caused by cracks in the propellant that expose greater areas to burning.
- (d) Fire rocket motors only when personnel are clear of the danger area. When a rocket motor is fired, the blast of hot gases and flame from the rear of the rocket motor causes the high-velocity discharge of small missiles such as fragments of wiring, plugs, closures, and unburned propellant in the danger area.

c. Handling of Misfires.

(1) *Drogue gun.*

- (a) Never stand in line of fire of the drogue gun.
- (b) If the parachute door has not opened with the impact

of landing, clear the area in the line of fire of the drogue gun. Stand on the right side of the drone and open the parachute door, thus firing the drogue gun.

- (c) If the parachute door has opened and the drogue gun has not fired, either the cartridge is defective or the firing pin is bent. Remove the drogue gun from the drone and disarm under the direction and supervision of the drone section commander.

(2) *Squibs.*

- (a) Disconnect all power supply and impact switches, then remove the squib leads from the input connector cable and replace the static ground wire.
- (b) Carefully remove squibs from load release bolt. If the leads are broken, discard the squib as a dud; if the leads are intact, replace in storage for future use.

(3) *Rocket motor.*

- (a) Misfires or hangfires may be encountered, especially under extreme weather conditions or other adverse circumstances. Take all practicable precautions to prevent malfunction and entry of moisture into the rocket motor or igniter. Inspect exposed lead wires and connections.

Warning: Do not use a battery-powered meter device to check the continuity of the rocket motor.

- (b) After a misfire or hangfire, the launcher chief—
 1. Checks the cable connection to the launch control box, checks the cable to the launcher and, if no defects are found, presses the firing button three times.
 2. If the rocket motors fail to fire after the third attempt, disconnects the launcher cable and waits the prescribed time.

Caution: A misfire cannot be immediately distinguished from a hangfire; therefore, a 20 minute waiting period is prescribed before approaching the drone.

Warning: If the detonating caps have fired, the plastic plug in the neck of the rocket motor may be free of the bottle; or if a dull explosion is audible with a puff of smoke, the rocket motor detonator has fired.

- (c) After the time limit has elapsed, the launcher chief proceeds to the drone. While standing at the left rear of the wing facing forward, he turns off the ignition

switch on the main junction box. If examination reveals a defect in the firing system, the rocket motors may be used again. If no defects exist, he notifies the local ordnance demolition team and treats the rocket motor as a dud projectile. The following method, however, can be used in the absence of qualified ordnance demolition personnel:

1. Disarm rocket motors under the direction and supervision of the drone section commander.
2. Disconnect rocket motor plugs and replace shunt wires.
3. Replace safety strap on parachute door.
4. Remove rocket motors and carriers from the drone.

d. Recovery Procedures.

- (1) Do not recover a drone from a flight in the same area where the recovery team is retrieving a drone from a previous flight.
- (2) Recovery team personnel and equipment will remain well clear of the drone landing point while the drone is being recovered and is descending by parachute.

Warning: The squib fires immediately upon impact with the ground. Personnel will remain well clear of the area around the drone until parachute disconnects.

- (3) If the squibs should not fire upon impacting the ground, fire or disconnect them (c(2) above) prior to any retrieving operations.

Caution: Extreme care must be taken if the squibs are to be fired. Personnel will remain well clear of the area around the drone while the senior recovery crewman fires the squibs.

- (4) If the flight mission was a night photographic mission and all photoflash cartridges were not ejected, remove cartridges from the ejector before continuing the retrieving operations. Immediately replace the shunting primer clip, then store it in the original container.

CHAPTER 10

DECONTAMINATION

61. General

The action of wind, rain, dew, and sunlight eventually destroys chemical agents. The majority of biological agents will die off quickly in the open, while the radioactive products of a nuclear explosion start decay from the instant they are created. Thorough washing with hot soapy water will remove chemical, biological, and radiological (CBR) contamination. Personnel performing decontamination operations must wear complete outfits of special purpose protective clothing and impermeable (rubber) gloves and aprons. For further information on CBR decontamination procedures and on use of protective clothing and accessories, see FM 21-40, TM 3-220, and TM 3-304.

62. Decontamination for Chemical Agents

a. Drone. To decontaminate the drone, seek a location which has natural drainage and which is downwind of occupied areas. Point the nose of the drone upwind. The drone is now properly positioned for decontamination.

(1) *Washing procedures.*

- (a) Toxic chemical agents can be removed from the drone by thorough washing and scrubbing. This is best accomplished by spraying solvent emulsion cleaner, specification MIL-C-25179 (1:9 mixture with kerosene or standard solvent) on the drone exterior. Soak the emulsion cleaner for 10 minutes before removing with a high-pressure rinse. Any variable high-pressure water source is adequate for this purpose. One pound of soap powder and 1½ pounds of washing soda added to 50 gallons of water is an effective detergent to flush chemical agents from the outer drone surfaces. The effectiveness of the solution is greatly increased if the water is hot. Wash drone surfaces with the solution, using the following sequence:

1. Propeller.
2. Engine.
3. Cowl.
4. Fuselage forward of wing.
5. Top surfaces of wing.
6. Under surfaces of wing.

7. Rear section of fuselage.
 8. Tail surfaces.
- (b) Rinse the cleaner off the drone, working from the top down and from front to rear. Gently flood drone surfaces with water to remove most of the cleaner and contaminant without driving it into the seams. Then apply a high-pressure rinse at a slight slant from the vertical angle and deflected from the operator. Clean very dirty or greasy surfaces (where the agent will be dissolved) by brushing the surface and simultaneously rinsing with a reduced water pressure.
- (2) *Steam cleaning.* An alternate cleaning method is to wash the drone with wet steam cleaning machines. Rinse as outlined above, using hot water when possible.
- (3) *Final decontamination procedures.* When decontamination of exterior surfaces and engine has been completed, open all openings and start the engine. Engine heat will vaporize any residual contaminant not removed from the engine by the cleaner or steam cleaning operation (engine must not be run longer than 3 to 5 minutes). Inspect the interior for traces of contamination and remove internal components for separate decontamination if needed. For details of decontamination procedures, see TM 3-220. Following decontamination, move the drone to an uncontaminated location for aeration. Use dry mix or slurry to decontaminate the ground on which the drone was located.

Caution: Avoid use of DANC solution on the drone.

b. Instruments. Electrical devices containing heat-producing units (e.g., electron tubes) are decontaminated by heat given off during operation. Other instruments usually can be decontaminated by subjecting them to a prolonged blast of warm air or by storing them in a hot, well-ventilated room.

c. Automotive Equipment. Vehicles only lightly contaminated by spray can be decontaminated by aeration. Water (especially soapy or alkaline) both decomposes and washes off chemical agents. As soon as the tactical situation permits a short stop outside the contaminated area, the driver should decontaminate the vehicle as follows:

- (1) First, decontaminate the surfaces personnel are most likely to touch. Swab the interior surfaces with solvents. Make swabs from materials at hand and change frequently. Use soap and water or other alkaline solutions for nerve gas decontamination. Do not use gasoline for

treatment of fabrics, leather, or rubber on the interior of vehicles.

- (2) After the interior is decontaminated, swab the door handles, hood, windshield, or other surfaces personnel may touch with DANC solution, gasoline, or other solvents.

63. Decontamination for Biological Agents

A soap and water solution will serve effectively for biological decontamination. It acts as a remover of contaminating organisms and has some germicidal properties. Physical decontamination processes include use of boiling water or steam and the application of direct sunlight under dry conditions for several hours.

64. Decontamination for Radiological Agents

If time permits, take advantage of the natural decay of radioactivity before washing drones contaminated by nuclear fallout. Time must be allowed for the radiation dose rate to decay to an operationally acceptable level for further decontamination. Decontamination will be very difficult if the drone has flown through a nuclear cloud or has come in contact with nuclear particles while the engine is operating. Wash the exterior of the drone and engine thoroughly with hot soapy water and detergent as outlined in paragraph 62 above. If waste water flows into a river or stream, notify units downstream of contamination. If exposed to radioactive dust, decontamination personnel must wear protective masks, rubber gloves, aprons, and clothing. After washing down, the drone and the personnel must be monitored to determine whether further decontamination is necessary. For details of radiological decontamination, see TM 3-220 and FM 1-100.

CHAPTER 11

DESTRUCTION OF THE DRONE SYSTEM

65. General

When subject to capture or abandonment in the combat zone, the drone system will be destroyed to prevent use by the enemy. Destruction of the equipment will be accomplished only upon the order of the commander in accordance with orders of, or policy established by, the Army commander.

66. Method of Destruction

a. Destroy the drone system as follows:

- (1) *Smash.* Using sledge, axe, pickaxe, hammer, crowbar, or other suitable implement, smash all vital elements such as communications equipment (transmitters, transponders, etc.), test equipment, cameras, spare parts, switches, plugs, cable assemblies, engine cylinders, and propellers.
- (2) *Cut.* Using axe or machete, cut cables, cords, and parachutes and slash tires on vehicles.

Warning: Inflated tires may blow out when slashed. When practicable, deflate tires before slashing to prevent injury of personnel.

- (3) *Burn.* Pile combustible material beneath and around the equipment. Puncture all fuel tanks. Pour gasoline and oil over equipment and combustible material. Ignite by means of an incendiary grenade, by a burst from a flamethrower, or by a combustible train.
- (4) *Explode.* Explosives should be provided since rocket motors M-3 must be destroyed by detonation. Remove rocket motors M-3 from their packings, if possible, and pile the units (forward end down) in a trench or depression.

Warning: When stacking rocket motors for destruction, care should be exercised to prevent stray currents of electricity (from radar, radio transmitters, and electrical apparatus) from prematurely igniting the units. Usually the presence of a shorting clip or wire on the igniter leads, or the leads being twisted together, will prevent accidental functioning. However, careless and rough handling may cause loss of shorting devices

and at the same time develop static charges of electricity which may fire the rocket motor.

- (a) When planning for simultaneous detonation, prepare charges of **EXPLOSIVE** (TNT, using one 1-pound block (or equivalent) per charge, together with necessary detonating cord for each four unpacked units to be destroyed; in the "as packed" condition, prepare one 2-pound block per charge for each four units). Place the charges at regular intervals throughout the pile. The charges are most effective when placed on the nozzle end of the rocket motor.
- (b) Provide for dual priming to minimize the possibility of a misfire. For priming, either a nonelectric blasting cap crimped to at least 5 feet of safety fuse (safety fuse burns at the rate of 1 foot in 30 to 45 seconds and should be tested before using) or an electric blasting cap and firing wire may be used. Safety fuse, which contains black powder, and nonelectric blasting caps must be protected from moisture at all times. The safety fuse may be ignited by a fuse lighter or a match; the electric blasting cap requires a blasting machine or equivalent source of electricity.

Caution: Keep the blasting caps, detonating cord, and safety fuse separated from the charges until required for use. The above method may ignite rather than detonate some of the rocket motors. Suitable cover must be taken to protect from fragments of the rocket motors and from the unpredictable flight of ignited rocket motors.

Note. When practicable, the stacks of rocket motors should be covered with earth, after placing and priming the charges, in order to reduce the effective range of fragments and assure high-order detonation. For the successful execution of methods of destruction involving the use of demolition materials, all individuals concerned will be thoroughly familiar with the pertinent provisions of FM 5-25 and TM 9-1955. Training and careful planning are essential.

- b. Dispose of the shattered, burned equipment by burying in slit trenches or foxholes, or by throwing into streams.
- c. For detailed discussion of destroying specific equipment, see the appropriate technical publications.

CHAPTER 12

OPERATION UNDER EXTREME CLIMATIC CONDITIONS

67. General

Special precautions are necessary to protect the drone system from several extremes of hot and cold temperatures, dampness, and windblown sand and dust conditions which may be encountered.

68. Operation Under Arctic Conditions

Operation of the drone system in subzero (Fahrenheit) weather requires the use of heaters (obtained through regular supply channels). This enables the system to be used at any time. The heaters should be of a portable type that can be connected to the various power sources. The starter cart and drone will require shelter enclosure when exposed to ice formation. When idle for any length of time, this equipment (i.e., storage battery BB-421/USD-1 and any other component that might be harmed by arctic conditions) must be kept at a temperature above zero.

69. Operation Under Tropical Conditions

Operation of the drone system in the tropics requires specific procedures to offset harmful effects of the climate. Tropical dampness will cause fungus to grow on components that are not protected from such action. Electronic components should not be opened for inspection or repairs where directly exposed to the weather. Whenever possible, enclosed electronic equipment which requires opening should be sent to the maintenance area for servicing in the electronic maintenance van. If equipment is to be left outside of an enclosure, moistureproof covers are required for protection.

70. Operation Under Sand and Dust Conditions

If the drone system is to be used in areas where sand or dust is common, certain precautionary measures must be observed. When strong winds are blowing, protective covering for equipment is required to keep out the sand or dust. If the area is a desert region and the temperature high, personnel must be careful when handling metal equipment that has been exposed to the sun. Under these conditions, use protective covering for arms and hands. DO NOT open any equipment in exposed areas; move equipment to a shelter where it can be dismantled and inspected without harm to the components.

71. Operation of Drone System Cameras Under Unusual Conditions

For operation of KA-20A and KA-39A cameras under unusual conditions, see TM 11-6720-207-10 and TM 11-6720-203-10.

APPENDIX I

REFERENCES

AF Manual 55-6	Aerial Photographic Reconnaissance.
AFR 95-7 and -7A	Titling, Identification, and Disposition of USAF Aerial Photographic Negatives.
AR 320-5	Dictionary of United States Army Terms.
AR 320-50	Authorized Abbreviations and Brevity Codes.
AR 611-101	Manual of Commissioned Officer Military Occupational Specialties.
AR 611-201	Manual of Enlisted Military Occupational Specialties.
ASubjScd 11-34	Electronic Warfare (ECCM).
ATP 1-78E	Army Training Program for Aviation General Support Company—Aviation Battalion Infantry, Armored, Mechanized, and Airborne Divisions.
ATP 6-575	Field Artillery Target Acquisition Battalion.
ATP 21-114	Basic Combat Training Program for Male Military Personnel Without Prior Service.
FM 1-100	Army Aviation.
FM 5-25	Explosives and Demolitions.
FM 6-120	The Field Artillery Target Acquisition Battalion and Batteries.
FM 6-121	Field Artillery Target Acquisition.
FM 11-50	Signal Battalion Armored Mechanized and Infantry Division.
FM 17-70	Communications for Armored Units.
FM 21-5	Military Training.
FM 21-6	Techniques of Military Instruction.
FM 21-11	First Aid for Soldiers.
FM 21-26	Map Reading.
FM 21-30	Military Symbols.
FM 21-40	Small Unit Procedures in Nuclear, Biological, and Chemical Warfare.
FM 21-41	Soldier's Handbook for Nuclear, Biological, and Chemical Warfare.
FM 21-60	Visual Signals.
FM 24-150	Electronic Warfare (Ground Based).
FM 30-5	Combat Intelligence.
FM 30-20	Aerial Surveillance-Reconnaissance, Field Army.
FM 44-1	Air Defense Artillery Employment.

FM 44-120	Procedure and Drill Radio Controlled Airplane Targets.
TM 1-300	Meteorology for Army Aviation.
TM 3-220	Decontamination.
TM 3-304	Protective Clothing and Accessories.
TM 5-6115-232-10	Operator's Manual: Generator Set, Gasoline Engine: 10 kw, ac, 120v, 1 and 3 Phase, 120/240v, Single Phase, 120/208v, 3 Phase, 60 cycles; Skid Mounted (Hol-Gar Model CE-105-AC/WK8) w/Hercules Engine Model 1XB3ER (FSN 6115-631-6811).
TM 9-1370-200	Military Pyrotechnics.
TM 9-1900	Ammunition, General.
TM 9-1903	Care, Handling, Preservation and Destruction of Ammunition.
TM 9-1955	JATOS, General.
TM 9-1955-1	JATO, M3.
TM 9-2805-219-12	Service Instructions: Model 0-100-1 Aircraft Engines (McCulloch Motors).
TM 9-6166	Operation and Organizational Maintenance: Aiming Circle M2.
TM 9-8014	Operation and Organizational Maintenance: ¼-ton 4 x 4 Utility Truck, M38A1; ¼-ton 4 x 4 Front Line Ambulance, M170.
TM 11-401	Elements of Signal Photography.
TM 11-664	Theory and Use of Electronic Test Equipment.
TM 11-976A	Power Unit PU-26A/U.
TM 11-1247	Test Set, TS-147/UP.
TM 11-6625-261-12 & TM 11-6625-261-35	Audio Oscillators TS-382A/U, TS-382B/U, TS-382D/U, and TS-382E/U.
TM 11-5131	Oscilloscopes OS-5001/U, OS-5001A/U, OS-46/U, and OS-46A/U.
TM 11-6625-370-35	Voltmeter, Meter ME-30A/U, and Voltmeters, Electronic ME-30B/U and ME-30C/U.
TM 11-5527	Multimeters TS-352/U, TS-352A/U, and TS-352B/U.
TM 11-5821-215-12	Operator's and Organizational Maintenance: Flight Control Groups OA-2380/USD-1 and OA-2381/USD-1 (Ground Control Station Equipment).
TM 11-5821-215-35P	Field and Depot Maintenance Repair Parts and Special Tools List (Ground Control Station Equipment) for Flight Control Groups OA-2380/USD-1 and OA-2381/USD-1.
TM 11-5840-220-10	Operator's Manual: Radar Set AN/MPQ-29.

TM 11-5895-246-12	Airborne Drone Surveillance System AN/USD-1 Operator's and Organizational Maintenance.
TM 11-5895-246-35	Field and Depot Maintenance Manual: Airborne Drone Surveillance System AN/USD-1.
TM 11-5895-247-35	Field and Depot Maintenance Manual: Antenna Switching Unit SA-649/USD-1.
TM 11-5895-248-35	Radio Receiver R-943/USD-1, Operator's and Organizational Maintenance.
TM 11-5895-249-12	Operator's and Organizational Maintenance: Surveillance Drone Test Set TS-1299/USD-1.
TM 11-5895-249-35	Field and Depot Maintenance Manual: Surveillance Drone Test Set TS-1299/USD-1.
TM 11-5895-250-35	Field and Depot Maintenance Manual: Test Set, Surveillance Drone TS-1297/USD-1.
TM 11-5895-252-12	Operator's and Organizational Maintenance Manual: Transponder Set AN/DPN-62(V).
TM 11-6625-200-12	Operation and Organizational Maintenance: Multimeter ME-26B/U.
TM 11-6625-322-12	Operator's and Organizational Maintenance Manual: Signal Generator SG-351/USD-1.
TM 11-6625-274-12	Electron Tube Test Sets, TV-7/U, TV-7A/U, TV-7B/U, and TV-7D/U.
TM 11-6625-322-45	Field and Depot Maintenance Manual: Signal Generator SG-351/USD-1.
TM 11-6625-322-35P	Field and Depot Maintenance Repair Parts and Special Tools List for Generator, Signal SG-351/USD-1.
TM 11-6720-203-10	Still Picture Camera KA-20A; Operator's Manual.
TM 11-6720-207-10	Operator's Manual: Camera, Still Picture KA-39A.
TM 30-245	Photographic Interpretation Handbook.
TM 38-750	The Army Equipment Record System; Operation TAPER.
TM 55-1550-200-12	Operator's and Organizational Maintenance Manual: Surveillance Drone OA-2343/USD-1
TM 55-1550-200-35	Field and Depot Maintenance Manual: Surveillance Drone OA-2343/USD-1.
TB 11-6625-274-12/1	Test Data for Electron Tube Test Sets TV-7/U, TV-7A/U, TV-7B/U, and TV-7D/U.
DA Pam 108-1	Index of Army Motion Pictures, Film Strips, Slides, and Phono-Recordings.
DA Pam 310-series	Military Publications Indexes.

APPENDIX II

MISSION DATE SHEET, DRONE FLIGHT LOG, AND CHECKLISTS

DRONE FLIGHT LOG

LOCATION:	UNIT:	C.O.:
-----------	-------	-------

LAUNCHER CHIEF:	DATES:	MISSION:
-----------------	--------	----------

Flight No.	100					
Controller's Name	Travis					
Drone Serial Number	B 214					
Time Engine Started	0830					
Time Launched	0832					
Time Landed	0900					
Elapsed Time	28					
Launching	Normal					

DRONE FLIGHT LOG—Continued

LOCATION:

UNIT:

C.O.:

LAUNCHER CHIEF:

DATES:

MISSION:

Landing Command	Instant Chute					
Landing: Cause	End of Mission (EOM)					
Equipment	Beacon and Camera					
Damage	None					

REMARKS: Note by serial number all components which malfunctioned and the cause of malfunction.
Make additional remarks for each flight on back of this sheet.

DRONE SECTION

AIRFRAME AND ENGINE MAINTENANCE CHECKLIST

DRONE.....

DATE.....

ENGINE

- Propeller free of nicks and cracks.
- Engine clean, inside and out, and drained.
- Cooling fins tight, no excessive damage.
- Carburetor properly adjusted, diaphragm free of damage.
- Ignition leads free of damage.
- Timed correctly.
- Points set.
- Engine rpm (indicate rpm).
- Ports and carburetor covered.

WING

- Ailerons straight and function freely. Jam nuts tight.
- Link bolts tight, straight, and in good operating condition.
- Correct alignment.
- Wing attachment pins straight and tight.
- Tip may be used with brackets and pods.
- Wing lights installed and connected.

AIRFRAME

- Engine studs tight and straight.
- Forward section fuel line and impact switch cable in proper working condition. All bolts and nuts in place.
- Bulkheads flyable.
- Fuel section rocket motor pins and fittings in working condition, no leaks in tank and mounted straight. Tank drained.
- Mid section: mounts satisfactory, arms adjusted, doors adjusted and straight, bolts and nuts in place.
- Aft section: good base for empennage, straight, mounts are in operating condition.
- Empennage: straight, elevator functions properly.
- Drogue gun: tube straight, lanyard and firing mechanism functioning properly.
- Flare ejectors mounted and secured.
- All bolts installed, free of damage along the keel.
- General inspection of all nuts, bolts, rivets, fasteners, cowlings, and fairings indicate reliable performance.
- Outside surface clean.

Mechanic.....

MISSION DATA SHEET

UNIT		LAUNCH/SITE	DATE		AERIAL PLATFORM AND MODEL NUMBER				
TYPE MISSION AREA RECON	TIME FROM:	NIGHT FUSE TYPE	FLIGHT FUSE SET	ATMOSPHERIC COND		TURBU- LENCE	CAMERA MALFUNCTION		
				CLOUDS					
				RAIN					
ROUTE RECON	TO:			FOG					
POINT TGT									
MISSION NO.		PREPARED BY							

RUNS	ALT	HEADING	GROUND- SPEED	TIME OVER TGT	PHOTO		TGT AND MAP COORD	ON-CAMERA MAP COORD	OFF-CAMERA MAP COORD
					VERT	OBL			
1									
2									
3									
4									

5									
CAMERA TYPE	FOCAL LENGTH	APER-TURE	SHUTTER SPEED	ANGLE OF VIEW	LENS METER SETTING	FILTER TYPE	IMC SETTING (INCHES PER SEC)	CYCLING TIME (SEC)	FILM TYPE
PHOTO PROCESSING DATA		ROLL NO.		EQUIPMENT USED					
DEVELOPER		PREWETTING		DEVELOPING TIME (ACTUAL)	DEVELOPING TEMPERATURE	METHOD OF DRYING			
		YES							
		NO							

REMARKS

DRONE SECTION
CONTROL SYSTEM MAINTENANCE CHECKLIST

DRONE.....

DATE.....

INSTALLATION

- Receiver installed.
- Gyro installed.
- Antenna switcher.
- Servos.
- Battery.
- Junction boxes installed.
- All control cables connected.

TEST SET TS-1297

- Test set connected (TS-1297).
- Drone power off.
- Transfer switch external.
- Test set on, external power on.
- Cage gyro, drone power on.
- *Signal generator SG 351, cable 100 feet out, 200 microvolts.
- Check voltage and current on TS-1297.

COMMAND CHECKOUT

- Roll command right, check aileron travel.
- Roll command left, check aileron travel.
- Pitch command up, check elevator travel.
- Pitch command down, check elevator travel.

INSTANT CHUTE

- Delayed parachute.
- Time delay squib circuit.
- Night lights.
- Camera.
- Spare No. 3.

CONTROL SYSTEM MECHANIC.....

- Note.* For specific checkout procedures of accessories, see appropriate TM.
* Other transmitters operating in the area may interfere with drone checkout procedures while the drone is on the ground.

DRONE SECTION
LAUNCHER CHIEF PREFLIGHT CHECKLIST

DRONE.....

DATE.....

EQUIPMENT SECURED

- Receiver.
- Gyro.
- Servos.
- Antenna.
- Antenna switcher.
- Battery.

FUSELAGE AND FIXED SURFACE

- Cowling, fairings, cover, and doors secure.
- Horizontal and vertical stabilizer secure.
- Wing properly attached, wing bolt tight.
- Pods secured when installed.

ENGINE AND PROPELLER

- Engine properly mounted.
- No dirt or sand in engine or carburetor.
- Accessories tightly mounted.
- Spark plugs secure.
- "P" lead connected.
- Grounding strap attached.
- Cylinder head bolt tight.
- Magneto harness secure and free of damage.
- No loose cooling fins.
- Propeller properly installed and safety wired.
- Propeller in safe operating condition.
- Flare ejector properly installed (when used).

FUEL SYSTEM

- Filler cap and drain plug secure.
- Filler cap vent hole open.
- Fuel tank filled.
- No leaks in fittings, tank, or fuel line.
- No burrs on carburetor needle valve.

RECOVERY SYSTEM

- Drogue gun loaded and properly installed.
- Impact switches and squib cables secured.
- Chute untied and attached to risers.
- Squibs properly installed.
- Pilot chute attached to main canopy.

LAUNCHER

- Alignment.
- Shear pin sleeves for excessive wear.
- Locking clamp and latch bolt.
- Junction box continuity check.
- Control box for proper operation.
- Control cable safety check.

ROCKET MOTOR

- Loose or faulty wiring.
- Correct alignment.

LAUNCHER CHIEF-----

APPENDIX III

RECOVERY TRUCK, 1/4-TON

1. Accessory Components

A standard 1/4-ton utility truck can be quickly converted to a recovery truck to provide the drone section with a small highly-mobile recovery vehicle. A drone litter, one front litter mounting bracket, and one rear litter mounting bracket (fig. 70) are all that is needed to convert the utility truck. All components mount to the 1/4-ton truck, using bolts, nuts, and pins.

2. Fabrication of Mounting Brackets

The mounting brackets are of welded construction and can be fabricated locally using the dimensions given on the drawings contained in figures 71 and 72. If possible, aluminum material should be used for the brackets; steel will make a good substitute. Cotter pins are used for mounting the drone litter to the bracket. Threaded bolts the same size as the cotter pins may be substituted.

*Figure 71. Front mounting bracket.
(Located in back of manual)*

3. Preparation for Mounting Brackets

First, remove the top cover and rear curtain of the 1/4-ton truck and stow in accordance with the procedure outlined in TM 9-8014. Then remove the windshield assembly in accordance with the procedure in TM 9-8014; it should be left in the maintenance area since it can easily be broken if carried on the truck while loading or transporting the drone. Remove the spare wheel and tire from the mounting bracket and carry on the rear floor of the truck.

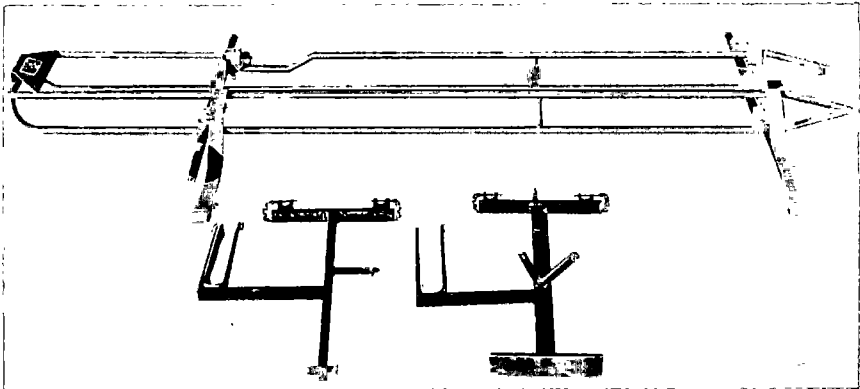


Figure 70. Components of mounted litter.

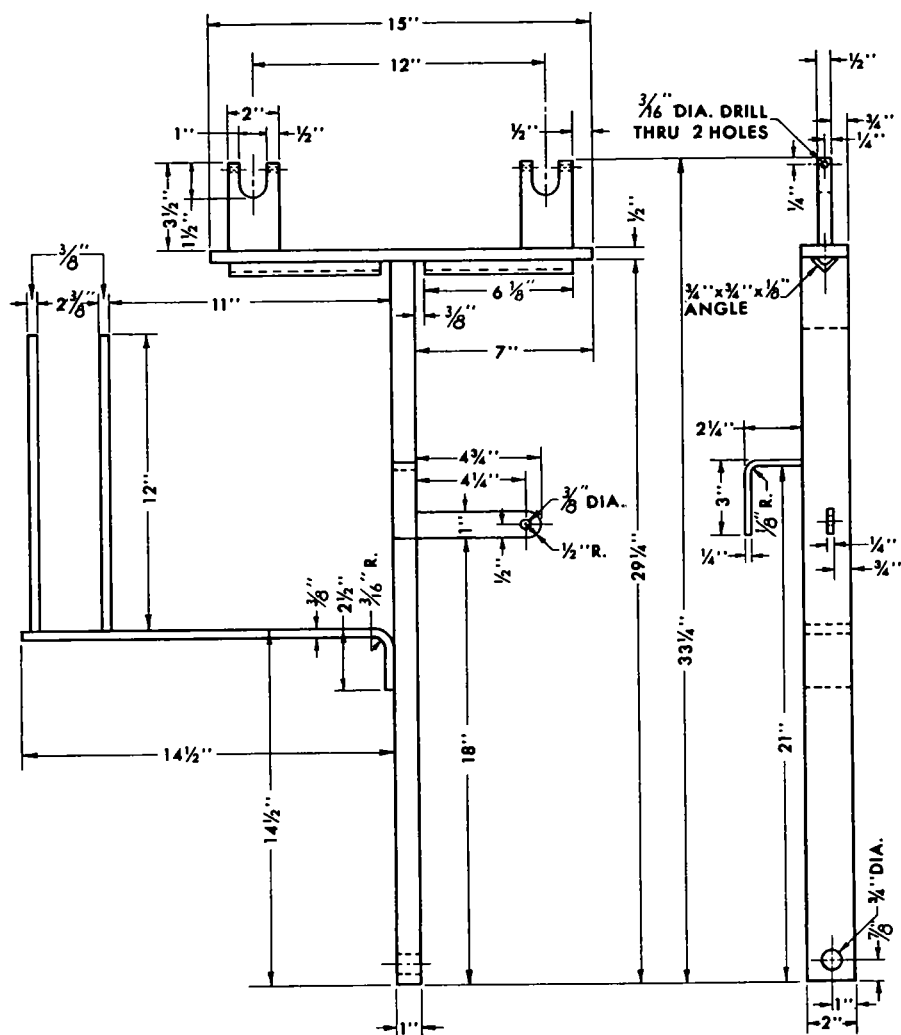


Figure 72. Rear mounting bracket.

4. Mounting the Front Bracket

a. Remove the first and third $\frac{7}{16}$ -inch diameter bolt from under the right side of the dashboard (fig. 73).

b. Place the front bracket on the front floor (fig. 74); simultaneously, place the rigidity hook over the handhold (fig. 73)

c. Replace and tighten the two $\frac{7}{16}$ -inch bolts. This completes the mounting of the front bracket.

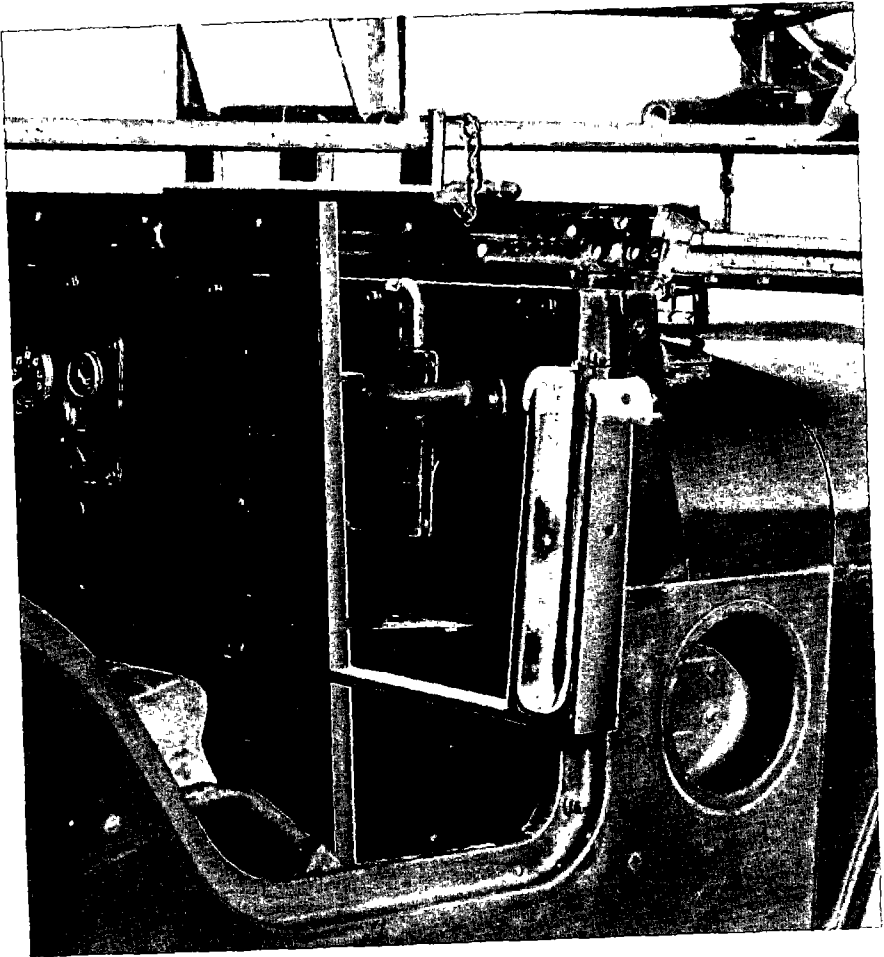


Figure 73. Mounted-front mounting bracket.

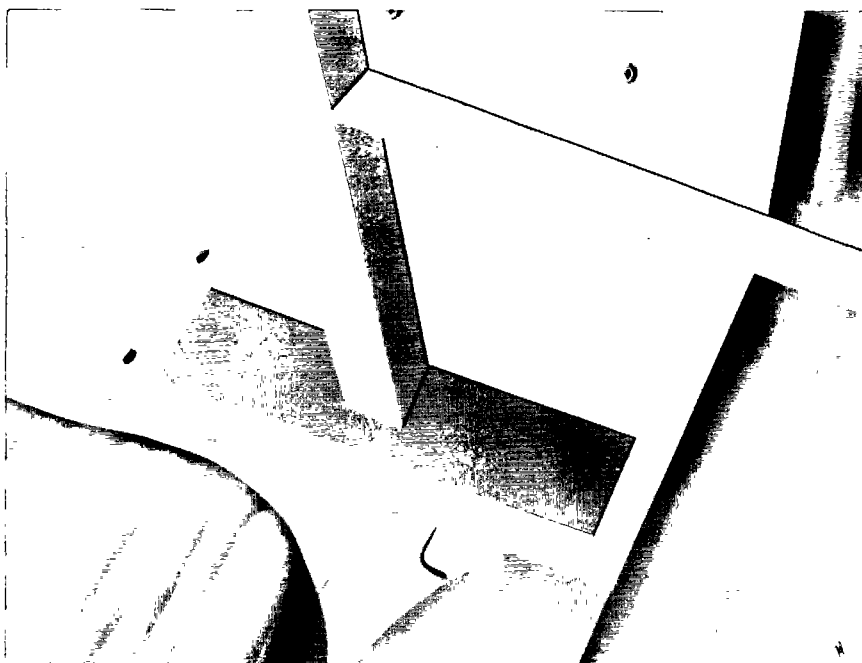


Figure 74. Floor support of front mounting bracket.

5. Mounting the Rear Bracket

- a.* Remove the right rear lifting shackle.
- b.* Remove the middle right nut that mounts the spare wheel mount to the truck.
- c.* Place the bottom of the rear bracket between the sides of the lifting shackle bracket (fig. 75) so that the shackle pin holes will be aligned with the bracket hole. Simultaneously hook the rigidity hook over the rear of the truck body (fig. 76). Also place the left stabilizing bar over the spare wheel mount stud and replace the nut.
- d.* Align the lifting shackle bracket holes with the bracket and replace the pin. The rear mounting bracket is completely mounted.

6. Mounting the Drone Litter

The drone litter is mounted on the brackets as shown in figures 73 and 75. When mounting, be sure to mount the center cross support bar of the litter into the "U" slot on the front bracket (fig. 73). This prevents the litter from shifting to the front or rear. When this is completed the $\frac{1}{4}$ -ton truck is ready for recovery (fig. 62).

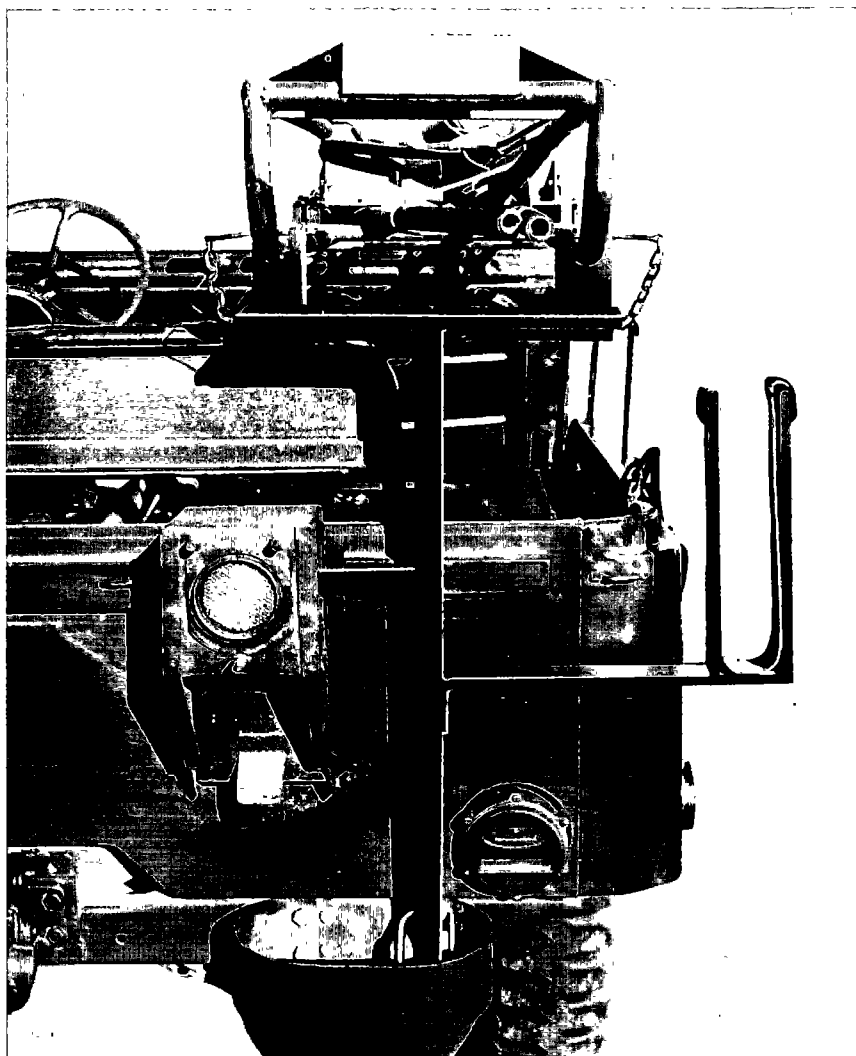


Figure 75. Mounted-rear mounting bracket.



Figure 76. Rear mounting bracket rigidity hook.

APPENDIX IV

RECOMMENDED TRAINING PROGRAM FOR AN/USD-1 DRONE SECTION

Section I. INITIAL TRAINING

1. General

This training phase is to be accomplished when the units initially receive their equipment and personnel. It can be used to supplement the flight training program included in section II.

2. Master Schedule

<i>Instruction Presented</i>	<i>Hours</i>
<i>a. Drone Section (1st Week).</i>	
(1) Uncrating, inventory, identification, testing, and storage of equipment.	40
(2) Safety lecture.	2
Subtotal	42
<i>b. Drone Airframe and Engine Personnel (2d Through 4th Week).</i>	
(1) Operational check of all ground-handling equipment and tools.	16
(2) Drone engine bench checks.	72
(3) Airframe check and adjustment.	20
(4) Recovery gear preparation and installation.	16
Subtotal	124
<i>c. Control System Maintenance Personnel and Drone Controller (2d Through 4th Week).</i>	
(1) Installation and operational check of test equipment.	16
(2) Airborne equipment bench and preflight checks.	72
(3) Transmitter check and tuning.	20
Subtotal	108
<i>d. Drone Crew Training (All Personnel) (5th Through 6th Week).</i>	
(1) System loading and unloading.	16
(2) Loading and unloading, launch site selection, launch setup, and preflight procedures.	24
(3) Maintenance and preflight procedures.	48
Subtotal	88

3. Scope of Instruction

Hours	Instruction presented	Scope	Study reference	Training aids
40	<i>a. Scope of Instructions Drone Section (1st Week).</i> Unerating, inventory, identification, testing, and storage of equipment.	Unerate and inspect all equipment for damage. Inventory and check against packing slips. Purge and lubricate drone engines. Test operation of starters, engines, and hoists. Store all equipment in cool, dry building. Identify all equipment in drones, spare equipment, and test equipment.	Use appropriate TM for particular piece of equipment.	
2	Safety lecture.....	A refresher conference to cover all phases of safety precautions to be observed while working with a drone system. Encompass: shop safety, loading and unloading equipment; handling of squibs, drogue gun, and rocket motors; POL; SOP; range traffic rules; launching safety procedures and field hazards (local); and procurement procedure for range flying.	Chapter 9 this FM, and TM 11-5895-246-12.	
16	<i>b. Scope of Instructions Drone Airframe and Engine Personnel (2d Through 4th Weeks).</i> Operational check of all ground-handling equipment and tools.	Check launchers for mechanical operations and electrical continuity. Under load, test hydraulic starters, litters, wing racks, generators, hoists, dollies, and the follow-	TM 11-5895-246-12 TM 55-1550-200-12 TM 11-900A TM 11-904	Appropriate AN/USD-1B drone equipment.

		ing special tools: propeller puller, magneto drive puller, and rocket motor and drogue gun cocking tools.	TM 9-8024	
72	Drone engine bench checks...	Check spark plug magneto points for proper gapping. Adjust carburetor diaphragms for proper movement. Time magneto to engine, using ohmmeter. Tighten all cylinder head bolts. Test fuel pumps. Test all drone engines on runup stands.	TM 55-1550-200-12 TM 9-2805-219-12	Twelve AN/USD-1B drone engines.
20	Airframe check and adjustment.	Check security of all bolted sections. Check freedom of movement of ailerons and elevator, also parachute door. Attach wings and see that wing attaching pins, wing boss, and shear bolt seat properly. Install engine on airframe and check security.	TM 55-1550-200-12	Twelve AN/USD-1B drone airframes.
16	Recovery gear preparation and installation.	Pack parachutes, cock drogue guns and rocket motor carriers, install parachutes in drones.	TM 11-5895-246-12	Twelve AN/USD-1B drone parachute special tools.
	<i>c. Scope of Instruction Control System Maintenance Personnel and Drone Controller (2d Through 4th Week).</i>			
16	Installation and operational check of test equipment.	Install in maintenance van and make operational check of all test equipment. Calibrate, tune, and align as required.	TM 9-8226 TM 11-2684A TM 11-5132 TM 11-5895-249-12 TM 11-6625-322-12 TM 11-5131 TM 11-6625-200-12 TM 11-5096 TM 11-5895-250-35	AN/USD-1B Drone maintenance shop van test equipment.

Hours	Instruction presented	Scope	Study reference	Training aids
72	Airborne equipment bench and preflight checks.	Perform complete bench tests of all airborne equipment for two drones. Install and preflight drones. (Continue this procedure until all airborne equipment and spare equipment is bench tested and preflighted in drones (12 drones) and rotate personnel so that each control system maintenance man has performed tests and installation on at least three drones.)	TM 11-6625-218-12 Manufacturers' Handbooks TM 11-5895-246-12 TM 11-5895-249-12 TM 11-5821-215-12 TM 55-1550-200-12	Drone AN/USD-1B and test equipment.
20	Transmitter check and tuning.	Perform bench tests, tune and align flight control systems (ground). (Rotate personnel so that each maintenance man has performed above procedures.)	TM 11-5821-215-35 TM 11-5821-215-12	Flight control system and test equipment.
	<i>d. Scope of Instruction Drone Crew Training (All Personnel) (5th Through 6th Week)</i>			
16	System loading and unloading rehearsal.	Practice in loading and unloading of entire system, moving to new locations and setting up maintenance area.	TM 11-5895-246-12 This FM	Drone system AN/USD-1B.
24	Loading and unloading, launch site selection, launch setup, and preflight procedures (dry run).	Practice in loading and unloading of equipment needed for performance of an assigned mission. Selection of different launch area sites, setup of launch area equipment (with drones) and preflight procedures up to an actual launch and performance of a mission. (Rotate per-	TM 11-5895-246-12 This FM TM 11-5895-252-12 TM 11-6720-203-10 TM 11-6720-207-10	

48

Maintenance and preflight procedures.

sonnel of section to various crews so all personnel have training in crew assignment.)

Using three drones, all control system maintenance personnel will bench test, align, tune, and make any needed repairs on airborne equipment and install it in drones. Check flight control system (ground) and spare equipment as deemed necessary. (Before start of bench tests, control system maintenance *NCOIC* will detune and maladjust all equipment to simulate equipment that has been used on a prior mission.)

All airframe and engine personnel will perform preflight procedures as outlined in this Field Manual. Necessary repairs to airframes and engines and adjustments to all ground-handling equipment will be made at this time. Parachutes will be packed and installed in the drones. Rotate personnel until all drones have been checked. (This is the last preflight prior to drone flying.)

All previous references.

AN/USD-1B System.

4. Subject Schedule	TOTAL HOURS	SUGGESTED SCHEDULE					
		Week of Training					
		1	2	3	4	5	6
Drone Section (1st Week)							
Uncrating, inventory, identification, testing, and storage of equipment.	40	40					
Safety lecture.	2	2					
TOTAL	42	42					
Drone Airframe and Engine Personnel (2d Through 4th Week)							
Operational check of all ground-handling equipment and tools.	16		16				
Drone engine bench checks.	72		24	40	8		
Airframe check and adjustment.	20				20		
Recovery gear preparation and installation.	16				16		
TOTAL	124		40	40	44		
Control System Maintenance Personnel and Drone Controller (2d Through 4th Week)							

Installation and operational check of test equipment.	16		16				
Airborne equipment bench and preflight checks.	72		24	40	8		
Transmitter check and tuning.	20				20		
TOTAL	108		40	40	28		
Drone Crew Training (5th Through 6th Week)							
System loading and unloading rehearsal.	16					16	
Loading and unloading, launch site selection, launch setup, and preflight procedures.	24					24	
Maintenance and preflight procedures.	48					4	44
TOTAL	88					44	44

5. Procurement of Training Literature

a. Department of Army publications will be procured through normal channels.

b. For additional training publications about the AN/USD-1 drone system, submit a letter of request to:

Commanding Officer,
Combat Surveillance and Target Acquisition Training Command,
Fort Huachuca, Ariz.

Section II. OPERATIONAL TRAINING

6. General

This training program is to be used as a guide by the unit commander to supplement the current ATP. In most cases, a 100-flight training program will be required to train the drone section to peak proficiency. This section of the program should be accomplished after completion of section I.

7. A 100-Flight Operational Training Program

Flights	Instruction training phase	Training requirements
a. 1-10	Individual	1. Refresher training for launch crew. 2. Refresher training for maintenance personnel. 3. Refresher training for controllers flying the drone in-sight.
b. 11-20	Team	1. Develop launch and recovery team techniques. 2. Develop team proficiency for all operations. 3. Begin use of tracking radar and controller training on radar. 4. Rotate all personnel to various jobs to obtain a broad knowledge of each team member's responsibilities. 5. Orientation of all personnel to the effects and problems encountered during electronic warfare. See ASubjSed 11-34.
c. 21-30	Team	1. Begin cross-training for controllers and launcher chief. 2. Begin use of cameras on short range radar tracking missions. 3. Begin in-sight night flying.
d. 31-40	Section	1. Move to tactical positions for section operation. 2. Begin beacon tracking with controllers flying the drone missions at increasing ranges. 3. Begin night flying with the controller controlling from the radars. 4. Make recoveries by the radar presentation and the talk-down method when out of sight.
e. 41-50	Section	1. Begin to fly night photographic missions insight. 2. Extend radar tracking missions to the maximum range of the drone and radar.

Flights	Instruction training phase	Training requirements
(e.—Continued)		3. Practice camouflaging techniques through the operational areas and on the drone.
f. 51-60	Section	1. Begin night photographic missions at extended ranges while controlling on radar. 2. Fly mission under all types of weather conditions commensurate with the mission. 3. By the sixtieth flight, all personnel should have been rotated to all positions that they may be required to fill.
g. 61-70	Platoon	1. Begin integration of operations with the aerial surveillance platoon. 2. Prepare and carry out a 2-day tactical training problem.
h. 71-85	Platoon	Prepare and carry out a tactical training problem employing the drone section in an integrated effort of the aerial surveillance platoon.
i. 86-100	Platoon	Prepare and carry out a tactical training exercise operating with the aerial surveillance platoon as a part of the GS aviation company.

APPENDIX V

USE OF CAMERA, FILM, AND FILTERS

This appendix contains—

Table I. KA-20A Photo Mission Planning Table.

Table II. KA-39A Photo Mission Planning Table.

Table III. Filter Table for Class L Film.

Table IV. Information required for film data strip.

Table I. KA-20A Photo Mission Planning Table.

Aircraft altitude (feet)	Drone altitude (feet)	IMC set	Film running time (min)	Aircraft photo coverage (yards)	Drone photo coverage (yards)	Aircraft photo scale	Drone photo scale
A 200	400	400	1.3	100	200	1:400	1:800
B 400	800	800	2.6	200	400	1:800	1:1,600
C 750	1,500	1,500	4.9	375	750	1:1,500	1:3,000
D 1,000	2,000	2,000	6.5	500	1,000	1:2,000	1:4,000
E 1,500	3,000	3,000	9.7	750	1,500	1:3,000	1:6,000
F 2,000	4,000	4,000	13.0	1,000	2,000	1:4,000	1:8,000

Note. For photo mission planning, use known factors to select the proper line (A through F) to obtain desired results. For example, a drone photographic mission is to be flown with a desired photo scale of 1:3,000. Line "C" provides the desired photo scale of 1:3,000; the drone must be flown at 1,500 feet above the terrain, with 4.9 minutes of film available, and the IMC setting is 1,500.

Table II. KA-39A Photo Mission Planning Table.

Aircraft altitude	Drone altitude	IMC set	Film running time (min)	Aircraft photo coverage (yards)	Drone photo coverage (yards)	Aircraft photo scale	Drone photo scale
A 500	1,000	1,000	3.7	250	500	1:1,000	1:2,000
B 750	1,500	1,500	5.5	375	750	1:1,500	1:3,000
C 1,000	2,000	2,000	7.4	500	1,000	1:2,000	1:4,000
D 1,250	2,500	2,500	9.2	625	1,250	1:2,500	1:5,000
E 1,500	3,000	3,000	11.0	750	1,500	1:3,000	1:6,000
F 2,000	4,000	4,000	13.0	1,000	2,000	1:4,000	1:8,000
G 2,500	5,000	5,000	18.4	1,250	2,500	1:5,000	1:10,000

Note. For photo mission planning, use known factors to select the proper line (A through C) to obtain desired results. For example, a drone photographic mission is to be flown with a desired photograph coverage of 1,000 yards. Line "C" provides the desired drone photo coverage for 1,000 yards; the drone will be flown at 2,000 feet above the terrain, with 7.4 minutes of film available, and the IMC setting is 2,000.

Table 111. Filter Table for Class L Film.*

Haze condition	Altitude in feet	Light condition	Shutter speed	Filter color
Very light haze.	1,000	¹ Bright sun.	1/300	Clear.
	2,000-5,000	Bright sun.	1/300	Yellow.
	All altitudes.	Cloudy.	1/150	Yellow.
	All altitudes.	Overcast.	1/150	Clear.
Light to medium haze.	1,000	¹ Bright sun.	1/300	Clear.
	1,000-2,000	Bright sun.	1/300	Yellow.
	2,000-5,000	Cloudy.	1/300	Yellow.
	3,000-5,000	Cloudy.	1/150	Yellow.
	All altitudes.	Overcast.	1/150	Yellow.
Heavy haze.	1,000-2,000	¹ Bright sun.	1/300	Yellow.
	3,000-5,000	Bright sun.	1/150	Red.
	1,000	Cloudy.	1/300	Yellow.
	2,000-5,000	Cloudy.	1/150	Yellow.
	All altitudes.	Overcast.	1/150	Yellow.
	² All altitudes.	Overcast.	1/150	Red.

Note 1. In bright sunlight conditions, use a red filter and a shutter speed of 1/150th second when flying photographic missions over snow.

Note 2. Conditions requiring this use require the use of Class N film (ASA index 200).

* For night aerial photography with the KA-39A camera, use a shutter speed of 1/150th second, clear filter, and Class N film.

Table IV. Information Required for Film Data Strip

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
85	No. 217	R	109	20 Bde	12	MAR	62	1330	6"	2,000	0842S 14826E			Chengtu, China	Confidential
1	Negative under (automatically recorded by camera).								9	Time of day.					
2	Camera identification.								10	Focal length.					
3	Type of photography (will always be an "R" when the drone is on a reconnaissance mission).								11	Altitude.					
4	Mission number.								12	Geographical coordinates (degrees and minutes of latitude and longitude is shown).					
5	Command identification.								13	Applies to radar.					
6	Day.								14	Applies to radar.					
7	Month.								15	Descriptive title.					
8	Year.								16	Classification.					

Note. The film data plate records information on the edge of each frame of film. It is recommended that items 1 through 12 be shown on the data plate for each mission. The information may be written on the plate with a grease pencil. Items 9 through 16 must be added to the first and last exposure of each continuous strip of film. Item 15 can be substituted for item 12 at the discretion of the local commander. When identification stamping devices are used, items 1 through 15 can be stamped on each negative after the mission.

GLOSSARY

- Attitude*—The position of the drone with respect to the ground.
- Drone recovery*—The action taken to land an airborne drone. The act of giving the drone a CHUTE command which causes the parachute to deploy and descend the drone to its landing point.
- Drone retrieval*—The removal of the landed drone from the landing area.
- Drogue gun*—The component which ejects a 1½-pound projectile that pulls the pilot chute from the parachute compartment. The drogue gun includes a projectile, drogue gun body, cartridge, breech block, firing pin, spring, and sleeve.
- Emergency landing*—A landing made when the recovery system fails while the engine continues to operate and the drone cannot remain airborne.
- Flight control system*—The equipment normally installed in the drone for the purpose of controlling the flight of the drone. It includes an FM receiver, pitch and roll servo units, gyro, and antenna switcher.
- Forced landing*—A landing made when the recovery system fails and the engine stops and the drone cannot remain airborne.
- Ground control station*—The equipment normally situated on the ground for the purpose of controlling the flight of the drone. It includes an FM transmitter, audio frequency coder, flight control box, and antenna.
- Gust spread*—The difference between the current average wind-speed and the highest windspeed during the past 15 minutes.
- Gyro*—The automatic pilot roll and pitch stabilization control installed in the drone. The gyro consists basically of two gyroscopes, one of which maintains a vertical position and the other a horizontal position. Any changes in airframe attitude are sensed by potentiometer pickoffs mounted on each gyroscope gimbal axis. These pickoffs send electrical signals to the appropriate control surface servo motor, which moves the control surface in the proper direction to maintain level flight.
- Impact switch*—A gravity-actuated switch which is used in the electrical system to complete a circuit to the parachute squib release mechanism. With the first impact of the drone with the ground, the normally open switches in the impact assembly close. This completes the circuit to the squibs which fire and disconnect the parachute from the drone.
- Missile effect*—The blast from the orifice end of the rocket motor. This blast is capable of thrusting small stones, pieces of glass, and other loose objects for a short distance.

Pilot chute—The small parachute which pulls the main parachute from the parachute compartment.

Pitch—Rotation of the drone about its lateral axis. This movement is controlled by the elevator.

Recovery system—The equipment normally installed in the drone for the purpose of recovering the drone after completion of a mission. It includes a pilot parachute, main parachute, drogue gun, parachute riser harness, impact switch, and release mechanism.

Roll—The rotation of the drone about its longitudinal axis. This movement is controlled by the ailerons.

Starter dog—The engaging mechanism found on the starter cart. The starter dog is a machined shaft with internal splines for insertion into a starter motor. Protruding from the sides of the shaft are two tips (dogs) which engage slots in the drone engine propeller hub.

Squib—A tube filled with explosive powder used to disconnect the main parachute from the riser harness.

Umbilical cable—The interconnecting cable assembly from the main junction box on the drone to the GO-NO-GO test console. This cable assembly contains all the necessary wires to connect the complete drone electrical system to the test console.

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Active Army:

DCSPER (1)	USATMC (5)
ACSI (1)	USASTCFM (7)
DCSOPS (5)	CSTATC (135)
DCSLOG (2)	Units org under for TOE:
Tech Stf, DA (1) except	(1 copy each)
CofT (5)	5-346
USAAVNBD (5)	5-348
USCONARC (10)	6-501
ARADCOM (1)	6-575
ARADCOM Rgn (1)	6-576
OS Maj Comd (5)	6-577
MDW (1)	11-5
Armies (10)	11-15
Corps (5)	11-17
Div (3)	11-32
Bde (2)	11-54
Avn Bn (3)	11-55
Avn Co/Btry (3)	11-66
Avn Det/Team (3)	11-67
Instl (2)	11-68
USMA (2)	11-96
Svc Colleges (3)	11-117
Br Svc Sch (5) except	11-155
USAAVNS (13)	11-157
USATSCH (5)	11-158
USARIS (21)	11-165
USA Ord Sch (5)	11-555
USAINTS (14)	39-52
USAES (5)	44-2
USACMLCSCH (5)	44-8
USASWS (7)	44-12
ARADSCH (10)	44-102
USAARMS (50)	44-112
USATATSA (5)	51-15

NG: None.

USAR: Same as Active Army except allowance is one copy to each unit.

For explanation of abbreviations used, see AR 320-50.

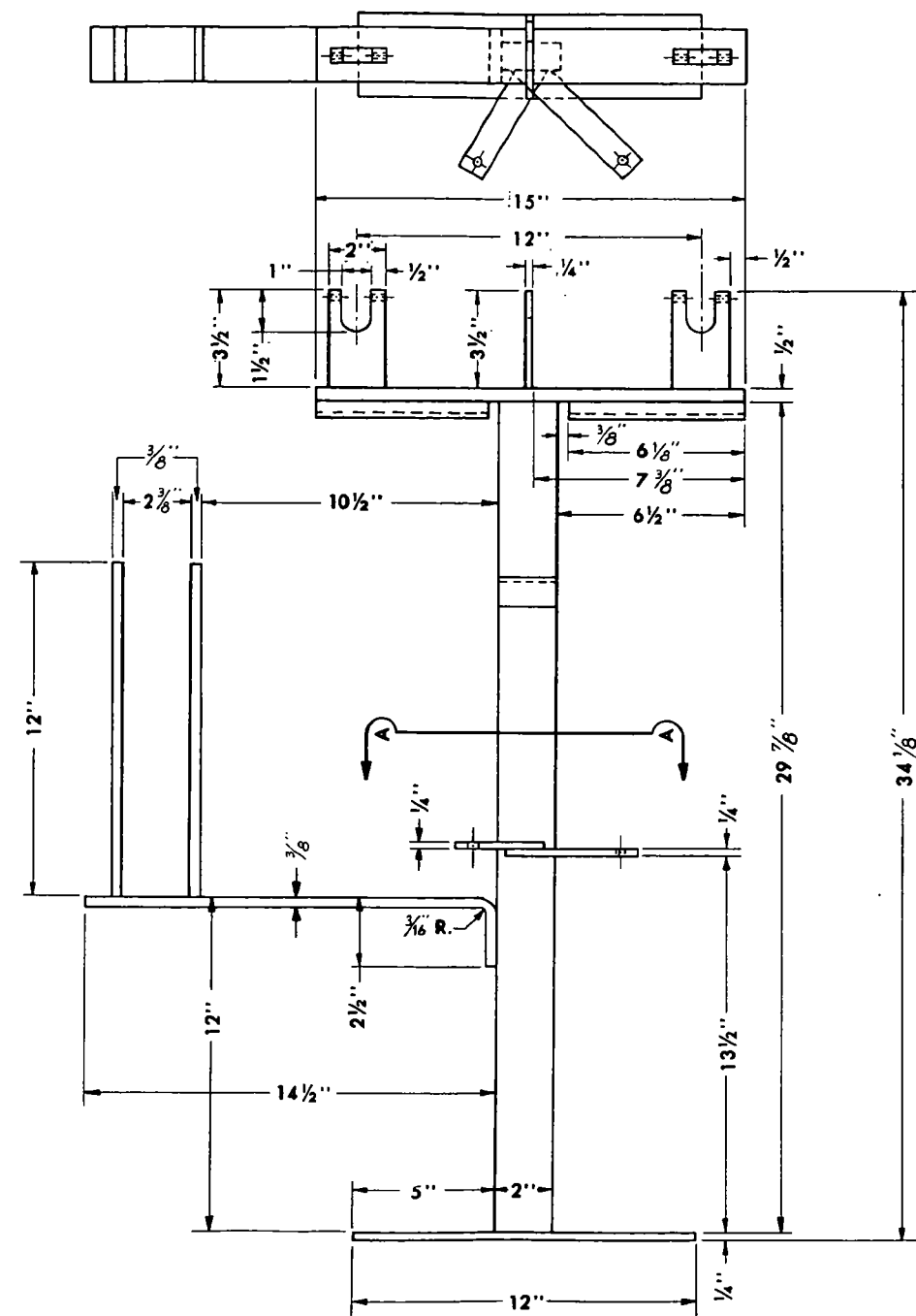


Figure 71. Front mounting bracket.

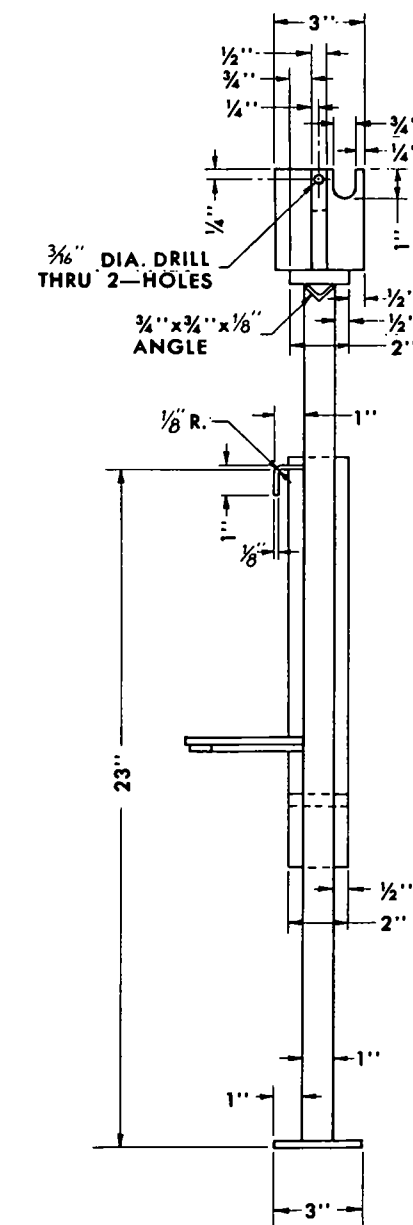
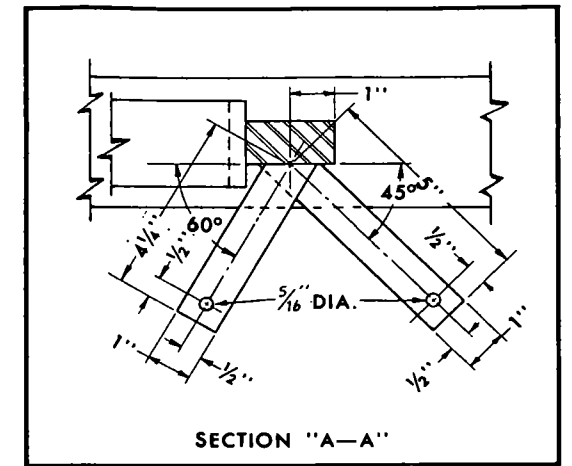


Figure 71.



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